(Systems) Frames الإطارات

نسألكم الدعاء

IF you download the Free ***APP.*** **RC Structures** YASSER EL LEATHY *on your smart phone or tablet, you will be able to play illustrative movies For any paragraph that has a QR code icon*

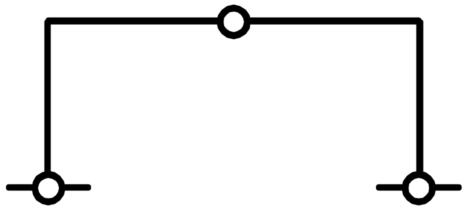
اذا حملت تطبيق **RC Structures** YASSER EL LEATHY على تليفونك المحمول او اللوح السطحى ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

Frames. Table of Contents.

Types of Frames.

توجد أنواع عديده من ال Frames سندرس أشهرها و هى :

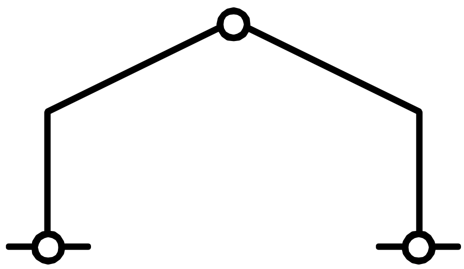
ⓐ 3 Hinged Frame.



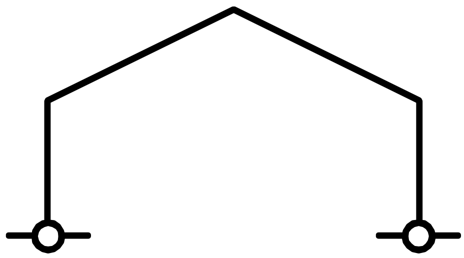
ⓑ 2 Hinged Frame.

ⓒ Fixed Frame.

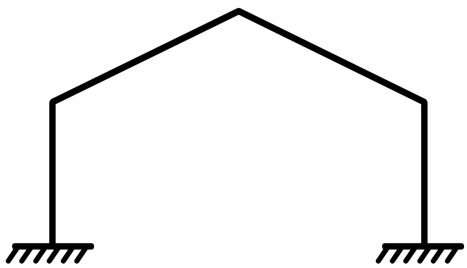
ⓓ 3 Hinged Inclined Frame.



ⓔ 2 Hinged Inclined Frame.



Ⓕ Fixed Inclined Frame.

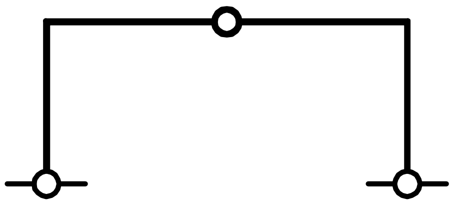


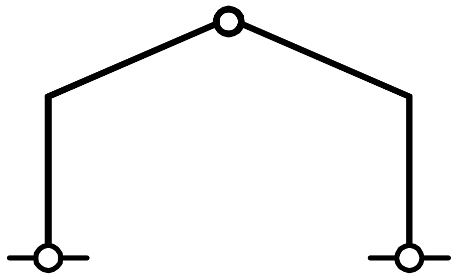
قاعده هامه .

كلما زاد عدد درجات الـ Indeterminacy للـ system

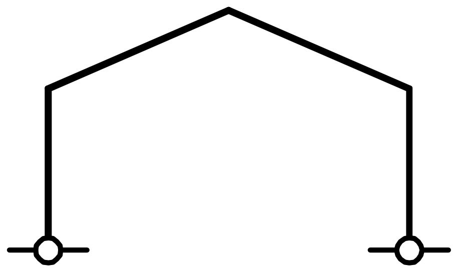
كلما قلت قيمه الـ moment و بالتالى يكون الـ system أرخص .

3 Hinged Frame. Detreminate



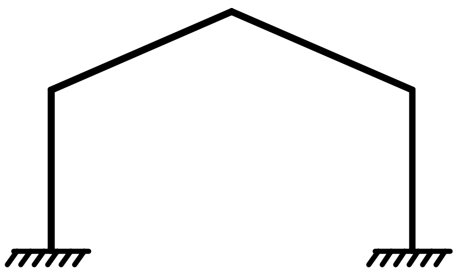


2 Hinged Frame. Once Statically Indetreminate



Fixed Frame. Twice Statically Indetreminate

لانه symmetric



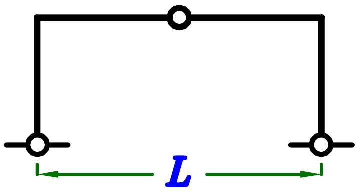
∴ Fixed Frame أرخص من 2 Hinged Frame أرخص من 3 Hinged Frame

Span of Frames.

كلما كان لل system عدد درجات Indeterminacy أكبر

كلما أستطعنا أن نزيد من span ال system

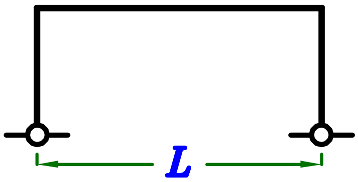
3 Hinged Frame.



$L = (12 \rightarrow 15)\,m$

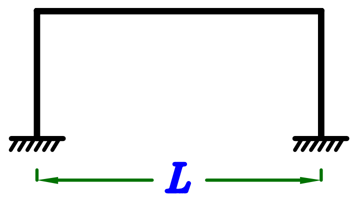
و تصل الى 24 m فى حاله التربه الضعيفه

2 Hinged Frame.



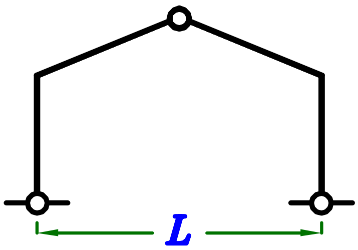
$L = (12 \rightarrow 22)\,m$

Fixed Frame.



$L = (12 \rightarrow 24)\,m$

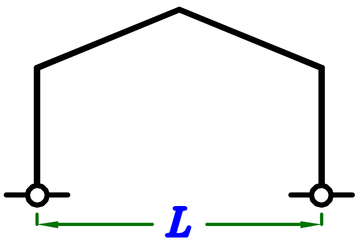
Inclined 3 Hinged Frame.



$L = (12 \rightarrow 15)\,m$

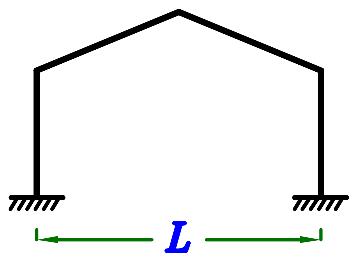
و تصل الى 24 m فى حاله التربه الضعيفه

Inclined 2 Hinged Frame.



$L = (12 \rightarrow 22)\,m$

Inclined Fixed Frame.



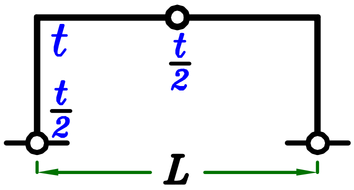
$L = (12 \rightarrow 24)\,m$

Depth of Frames.

كلما كان لل system عدد درجات Indeterminacy أكبر

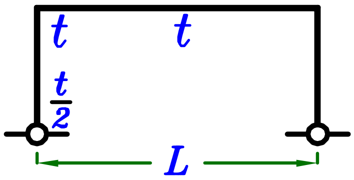
كلما أستطعنا أن نقلل من تخانه ال system

3 Hinged Frame.



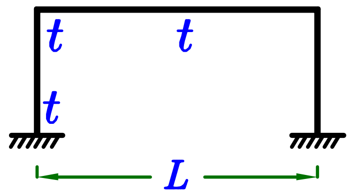
$$t \simeq \frac{L}{10}$$

2 Hinged Frame.



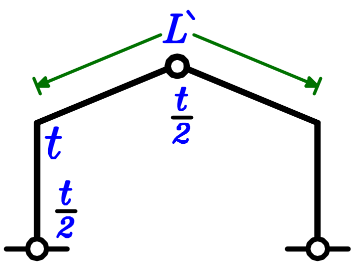
$$t \simeq \frac{L}{12 \rightarrow 14}$$

Fixed Frame.



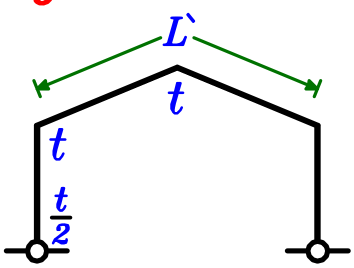
$$t \simeq \frac{L}{14 \rightarrow 16}$$

3 Hinged Inclined Frame.



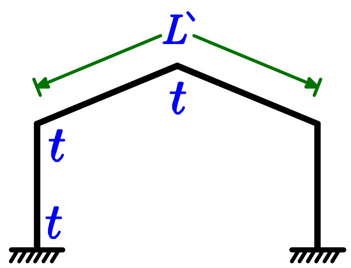
$$t \simeq \frac{L`}{10}$$

2 Hinged Inclined Frame.



$$t \simeq \frac{L`}{12 \rightarrow 14}$$

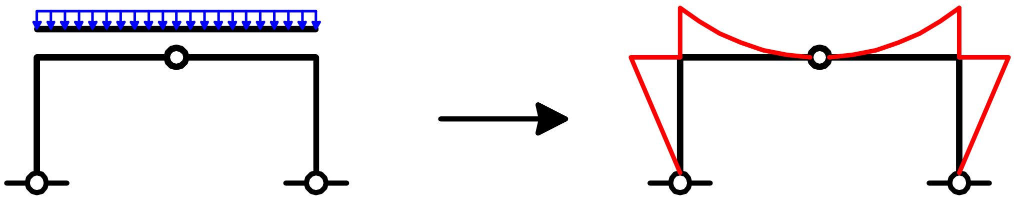
Fixed Inclined Frame.



$$t \simeq \frac{L`}{14 \rightarrow 16}$$

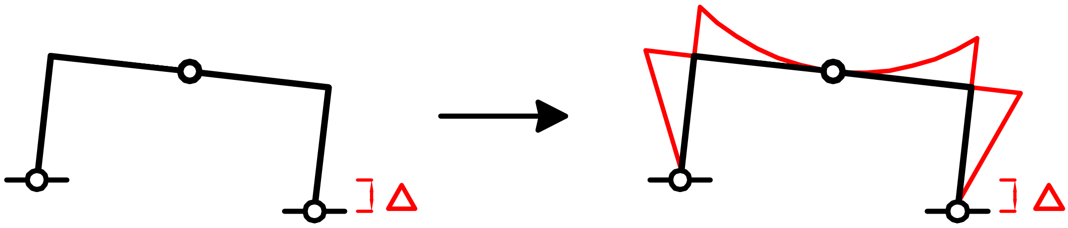
ملحوظه هامه.

لكن كلما كانت التربه أضعف أى متوقع حدوث ***Differential Settlement*** أكبر
كلما كان من الافضل أن نختار ***system*** عدد درجات الـ ***Indeterminacy*** له أقل .
لانه لو كان ***determinate system*** و حدث له هبوط لعمود واحد فقط
اتجاه الـ ***moment*** لن يتغير و بالتالى يكون الحديد الموضوع مناسب فلا يحدث انهيار للـ ***system*** .



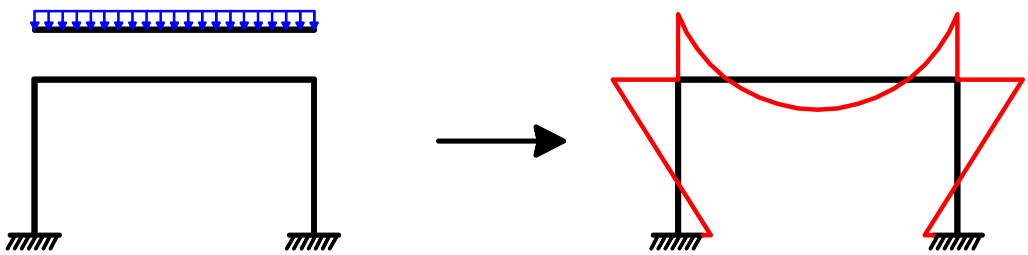
3 Hinged Frame.
Detreminate

شكل و اتجاه الـ ***moment*** للاحمال الرأسيه
الموضوع على اساسه التسليح



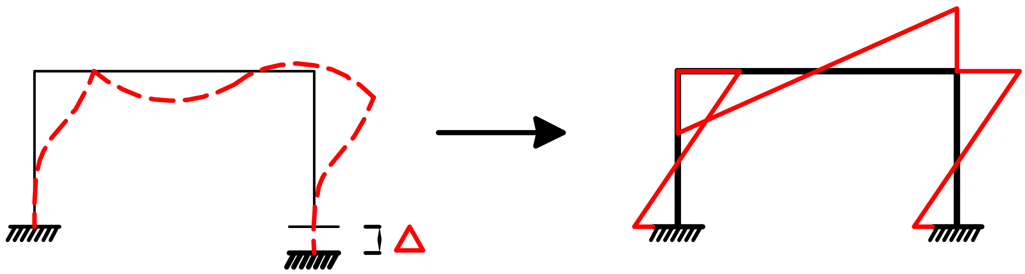
اتجاه الـ ***moment*** لم يتغير
اى نفس مكان التسليح الموضوع

لكن لو ***indeterminate system*** و كان عدد درجات الـ ***Indeterminacy*** كبير
عند حدوث هبوط لعمود واحد فقط يتغير اتجاه الـ ***moment*** عن اتجاه الحديد الاصلى
و بالتالى من الممكن ان يؤدى الى انهيار الـ ***system*** .



Fixed Frame.
Twice Statically
Indetreminate

شكل و اتجاه الـ ***moment*** للاحمال الرأسيه
الموضوع على اساسه التسليح



اتجاه الـ ***moment*** تغير اى لن يكون نفس مكان التسليح الاصلى
من الممكن ان يؤدى الى انهيار الـ ***system***

لذا اذا كانت التربه ضعيفه يجب استخدام *determinate system* حتى لو كان أغلى .

Choosing Type of Frame.

1- Type of Soil. Weak Soil. (Clay)

Span $(12 \rightarrow 24)m$

use $\boxed{\text{3 Hinged Frame}}$

2- Type of Soil. No Soil data. (or sand)

Span $(12 \rightarrow 22)m$

use $\boxed{\text{2 Hinged Frame}}$

3- Type of Soil. No Soil data. (or sand)

Span $(22 \rightarrow 24)m$

use $\boxed{\text{Fixed Frame}}$

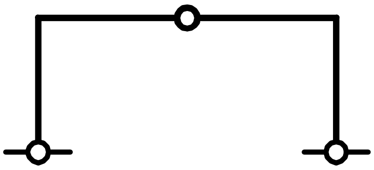
4- Type of Soil. Hard Soil (Rock or condensed sand)

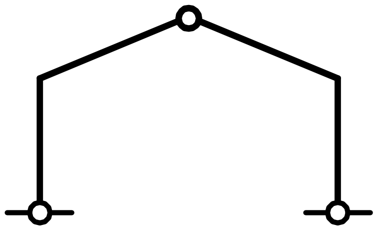
Span $(12 \rightarrow 24)m$

use $\boxed{\text{Fixed Frame}}$

Analysis Methods of Frames.

3 Hinged Frame. **3 Hinged Inclined Frame.**





→ **Determinate.**

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2 Hinged Frame.

Once Statically Indet.

Fixed Frame.

Twoice Statically Indet.
symmetric لانه

No Sway $\xrightarrow{\text{الاسهل}}$ **Moment Distribution**

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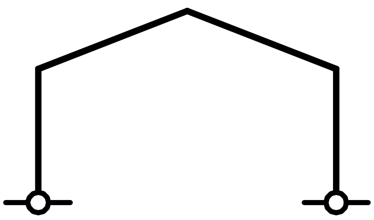
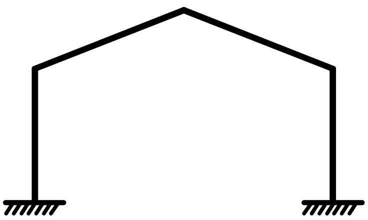
2 Hinged Inclined Frame.



Once Statically Indet.

→ **Sway** $\xrightarrow{\text{الاسهل}}$ **Virtual Work**

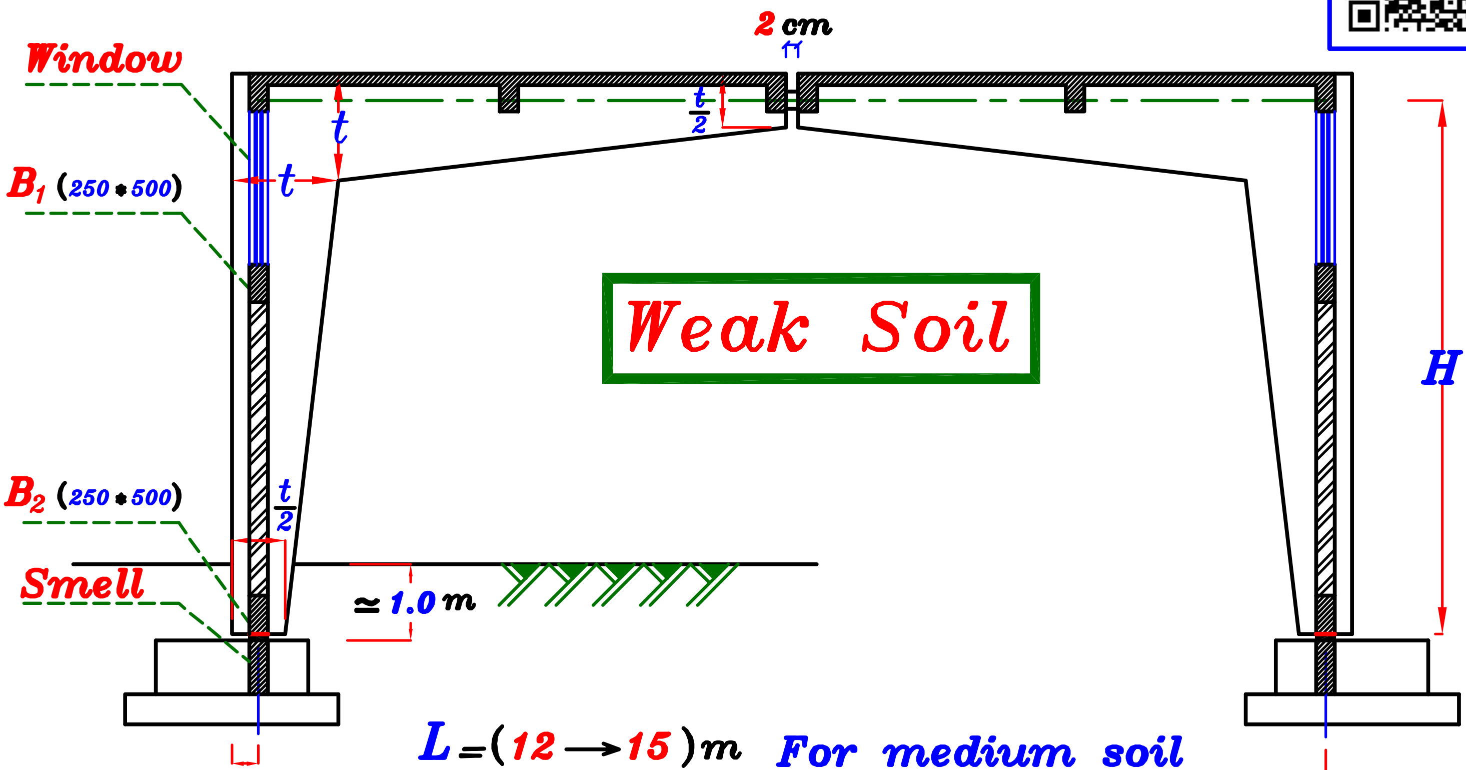
Fixed Inclined Frame.



Twoice Statically Indet.
symmetric لانه

→ **Sway** $\xrightarrow{\text{الاسهل}}$ **Approximate Method.**

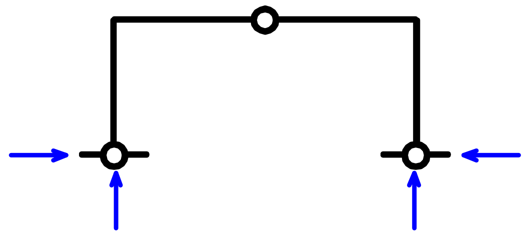
Three Hinged Frame.



$L = (12 \longrightarrow 15)\,m$ For medium soil

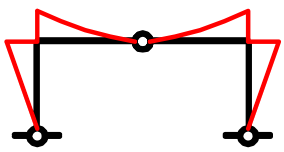
$ = (12 \longrightarrow 24)\,m$ For Weak soil

– Statical System

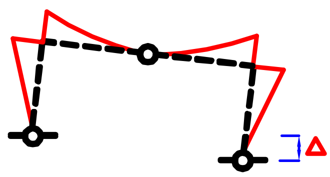


The 3 hinged Frame is Statically Determinate structure

So, It is better For WEAK soil.



B.M. Before Settlement



B.M. After Settlement

– Concrete Dimensions.

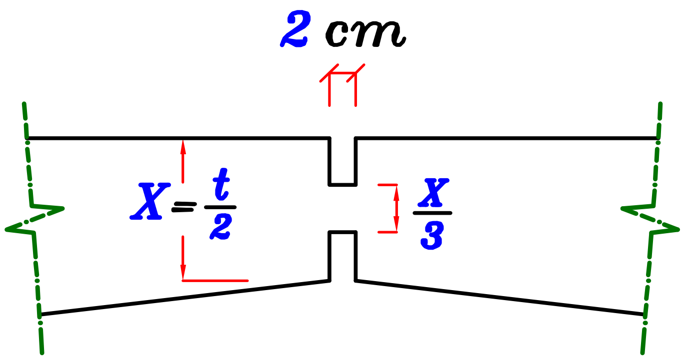
* Span (L) $= (12 \longrightarrow 15)\,m$ For medium soil

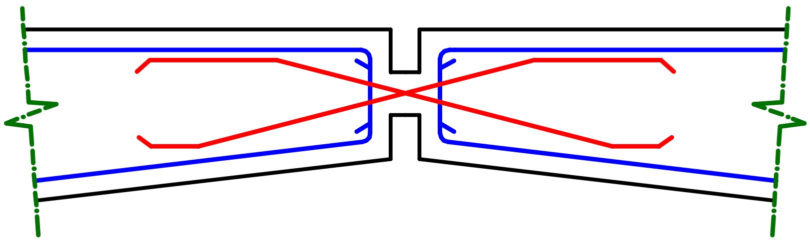
  $= (12 \longrightarrow 24)\,m$ For Weak soil

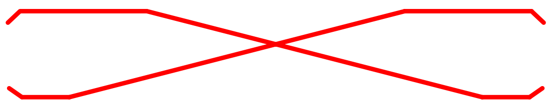
* $t \simeq \frac{L}{10}$

* $b = \left.\begin{matrix} 0.30\ m \\ \frac{\text{Spacing}}{20} \end{matrix}\right\}$ الأكبر

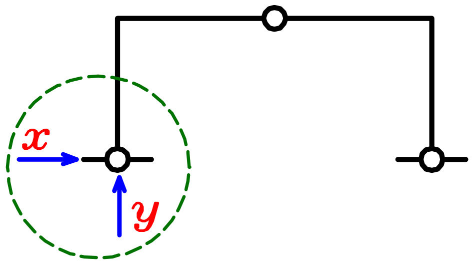
ـ يوجد فاصل بين الـ *Two Frames*
عباره عن *Hinge*

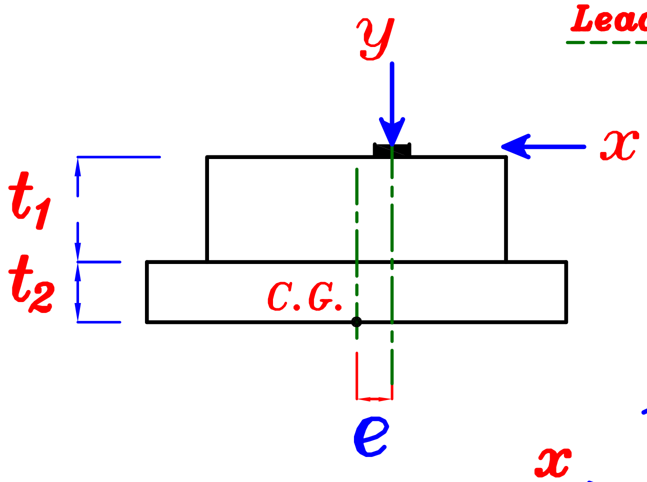


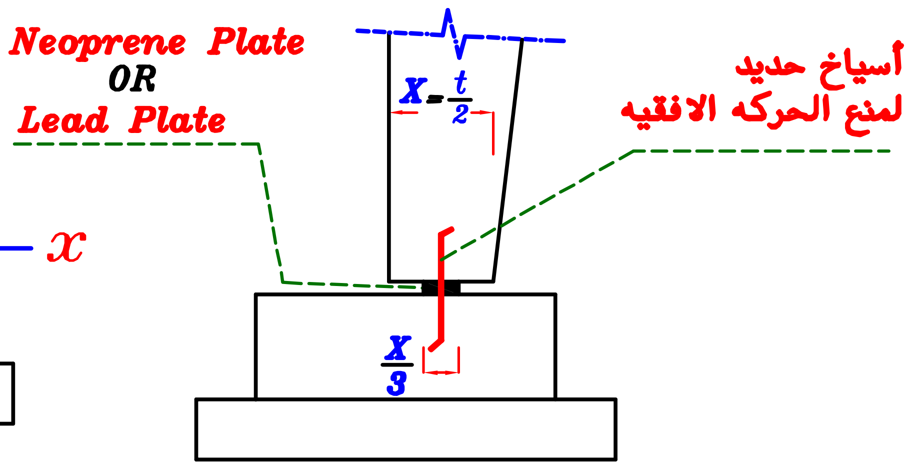


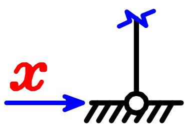


ـ القواعد عباره عن *Real Hinge*







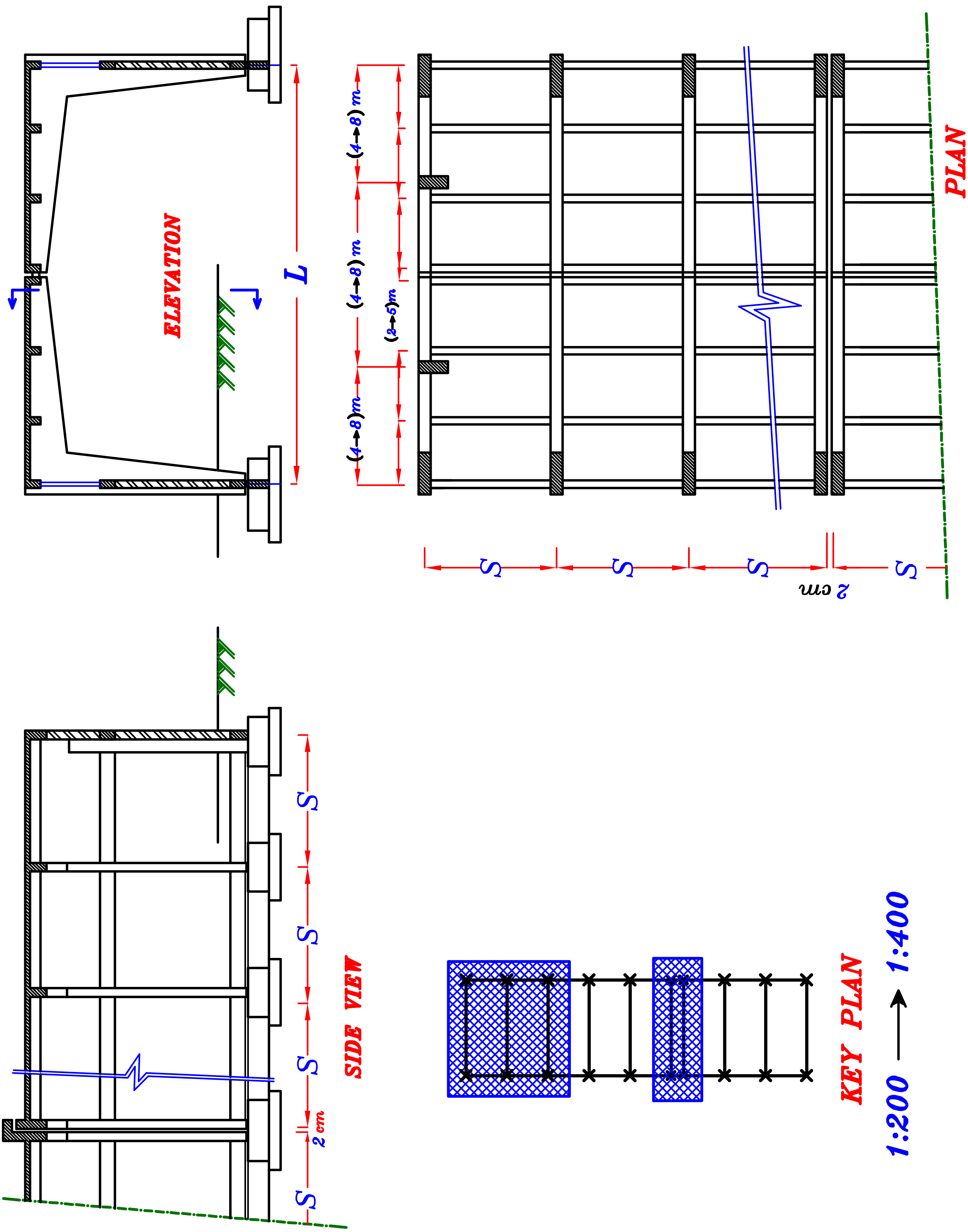


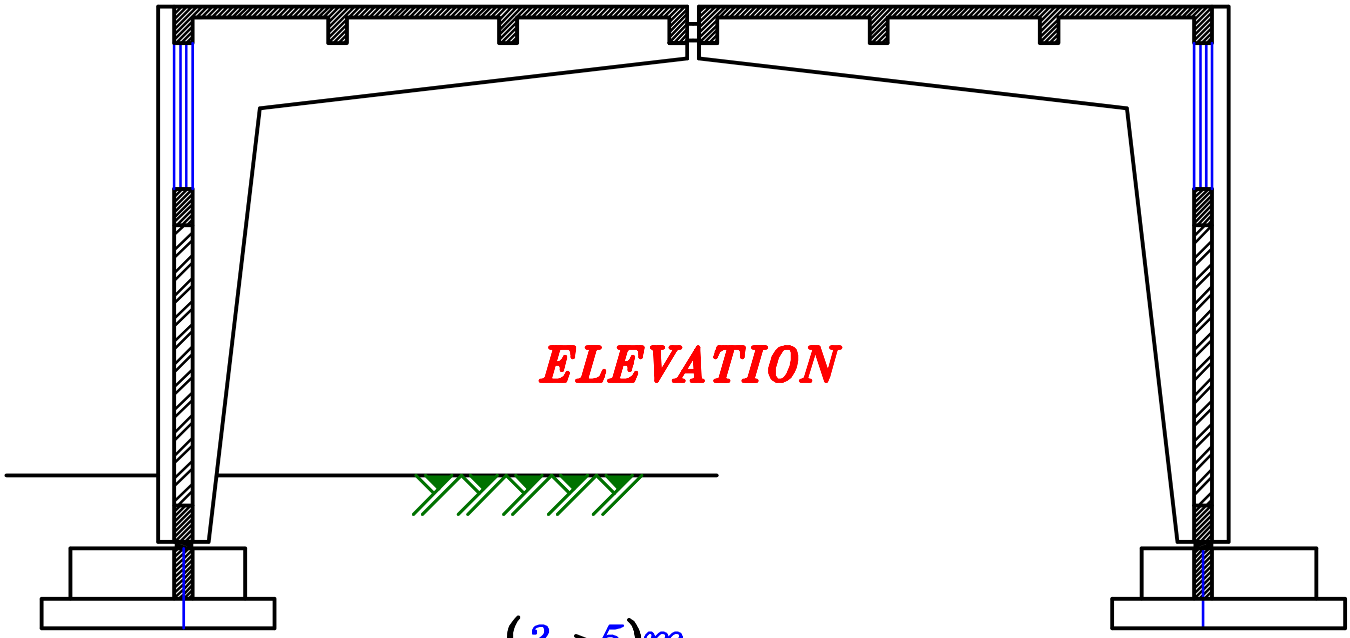
ترحل القواعد عكس إتجاه الـ (X)

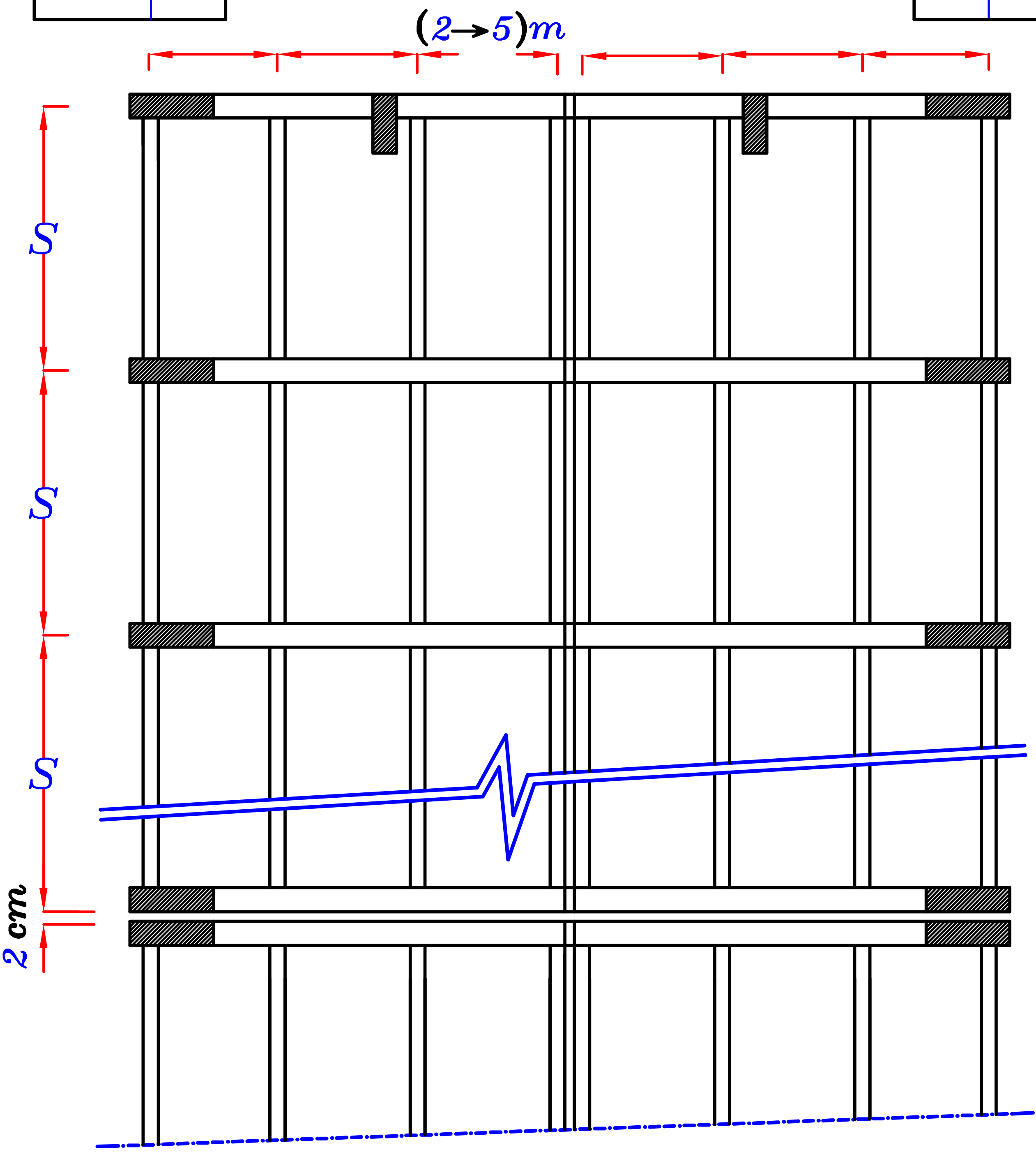
أى ترحل القواعد للخارج مسافه (e) لعمل *uniform stress* على التربه

$\because \sum M_{C.G.} = Zero \qquad \therefore x\,(t_1 + t_2) - y\,(e) = Zero$

$$\therefore \boxed{e = \frac{x\,(t_1 + t_2)}{y}} \simeq (0.25 \longrightarrow 0.50)\ m$$


ELEVATION
L
(4→8) m
(4→8) m
(4→8)m
(2→5)m
PLAN
S
S
S
S
2 cm
SIDE VIEW
S
S
S
S
2 cm
KEY PLAN
1:200 → 1:400





PLAN

Steps of Design.

خطوات المسأله .

١- اختيار ال *system*

٢- رسم *concrete Dim.* فى ال *Plan & elevation*

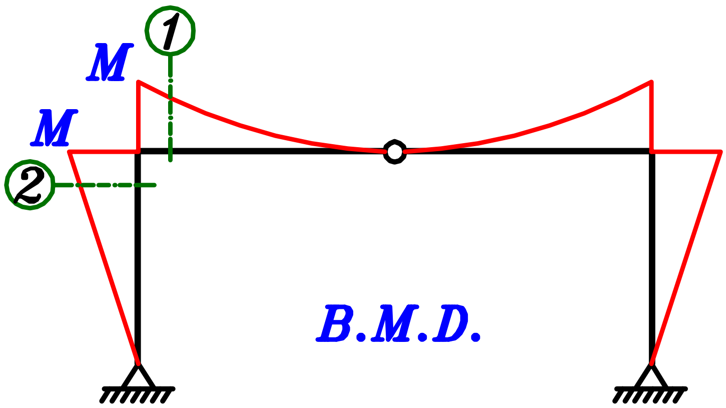
٣- رسم تسليح البلاطه على نفس ال *Plan*

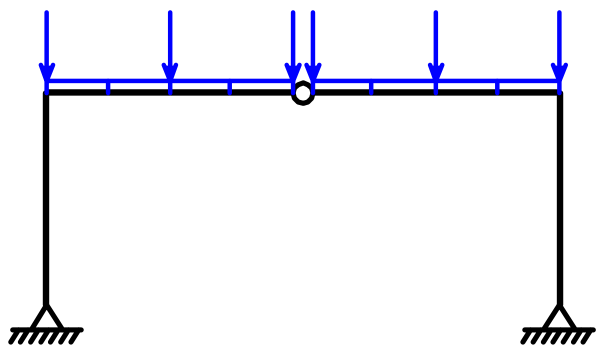
٤- عمل *Load distribution* للبلاطات و حساب الاحمال على ال *System*

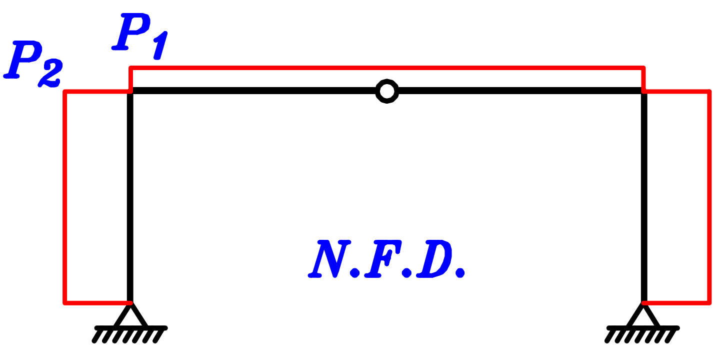
٥- حل ال *System* و رسم *B.M.D. & N.F.D.*

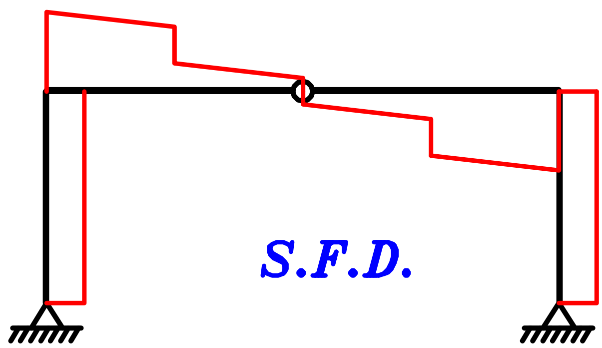
٦- تصميم قطاعات ال *System* على *M,P*

٧- رسم تسليح ال *System* فى ال *elevation & cross-sec.*









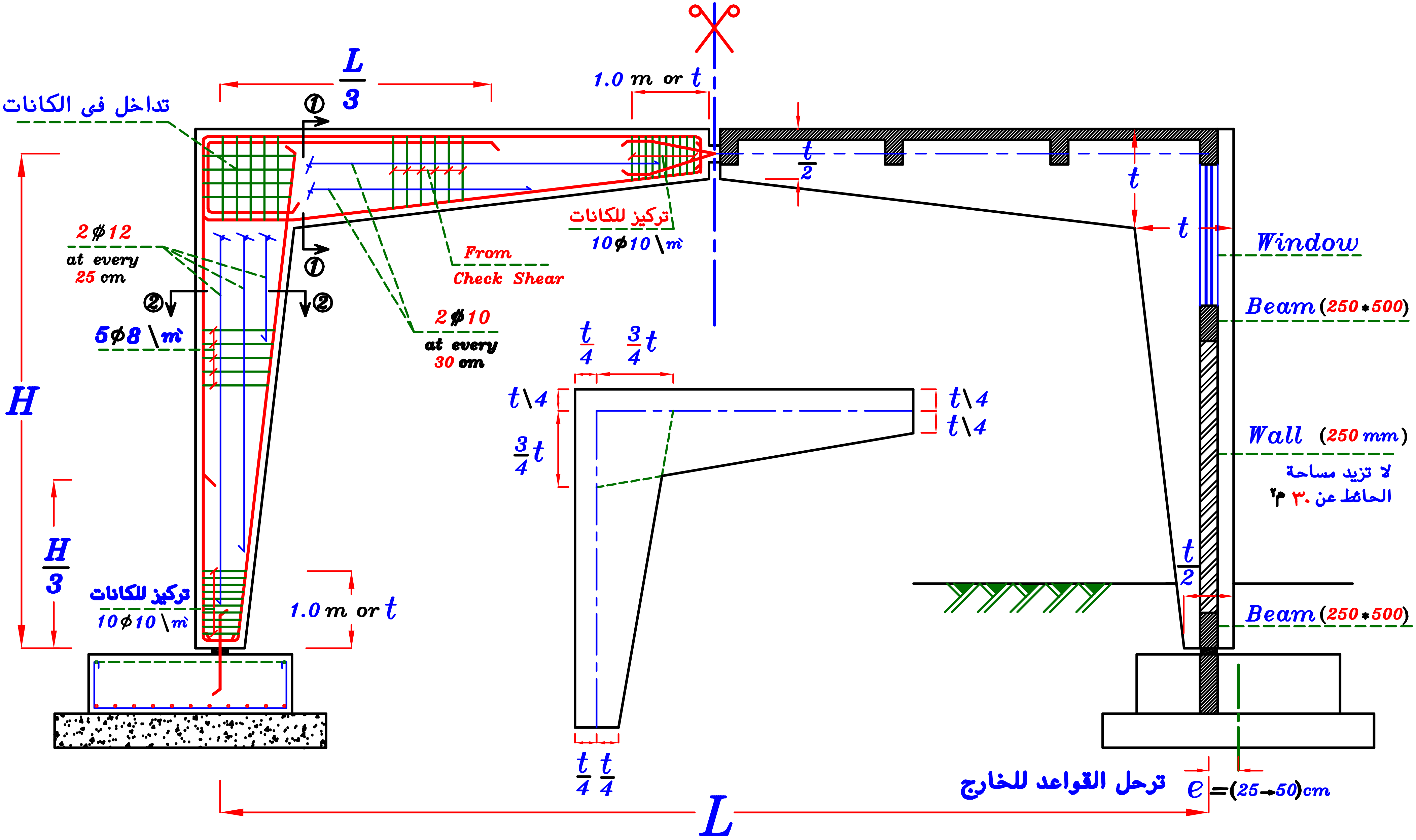
Design:

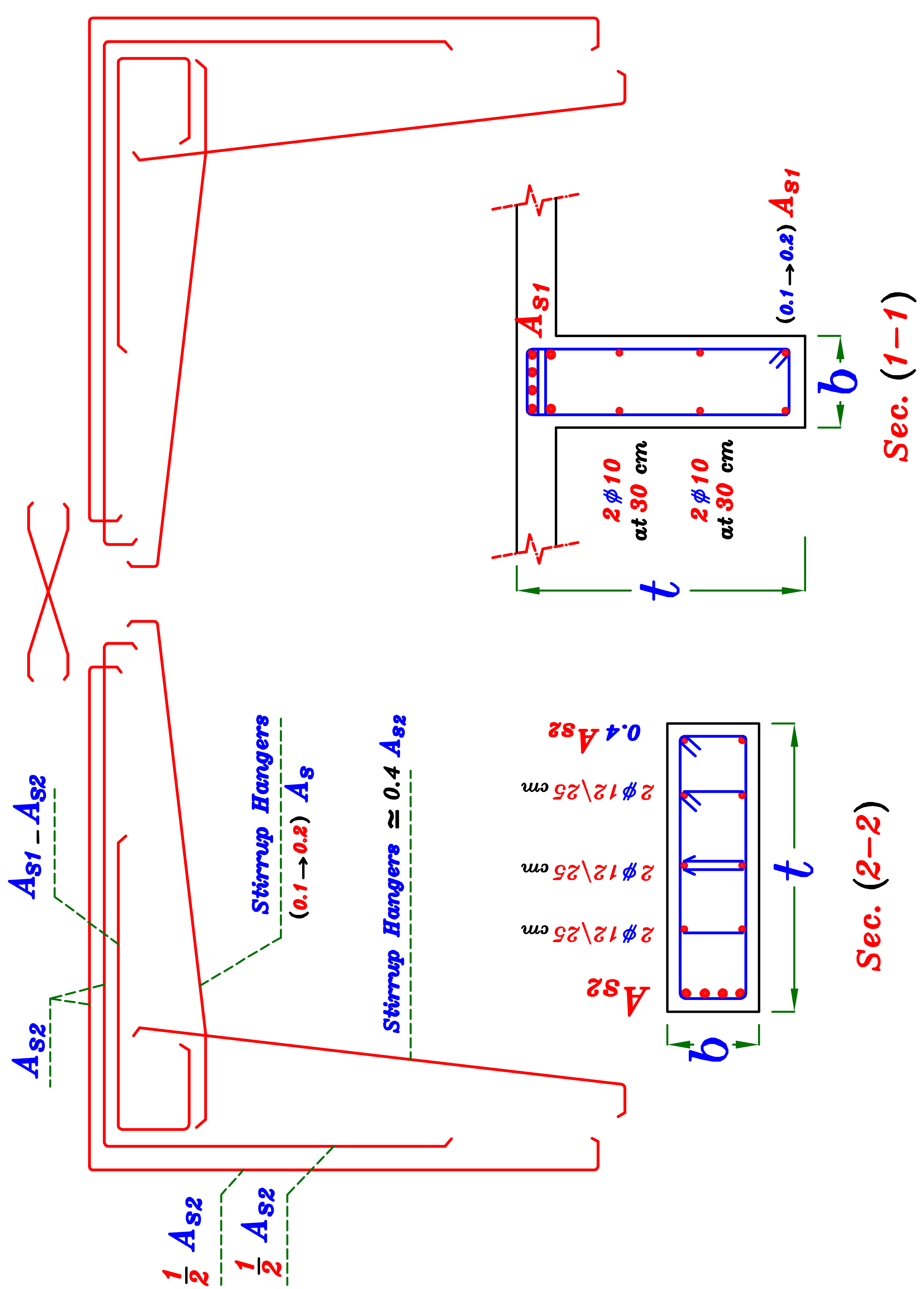
Sec. ① on $M, P_1 \longrightarrow$ Get A_{s1}

Sec. ② on $M, P_2 \longrightarrow$ Get A_{s2}

Note: $A_{s1} > A_{s2}$

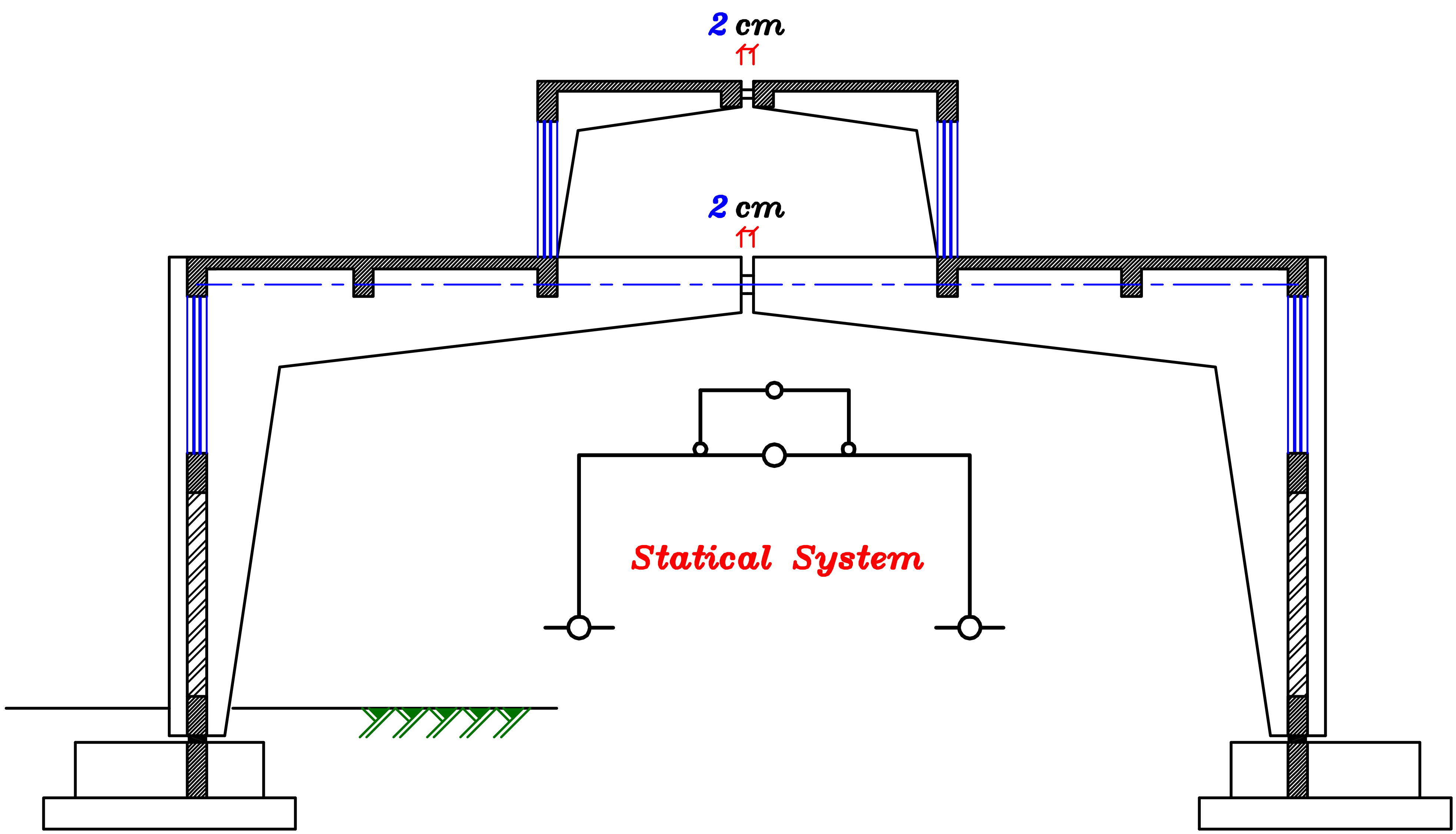
RFT. of the Frame.





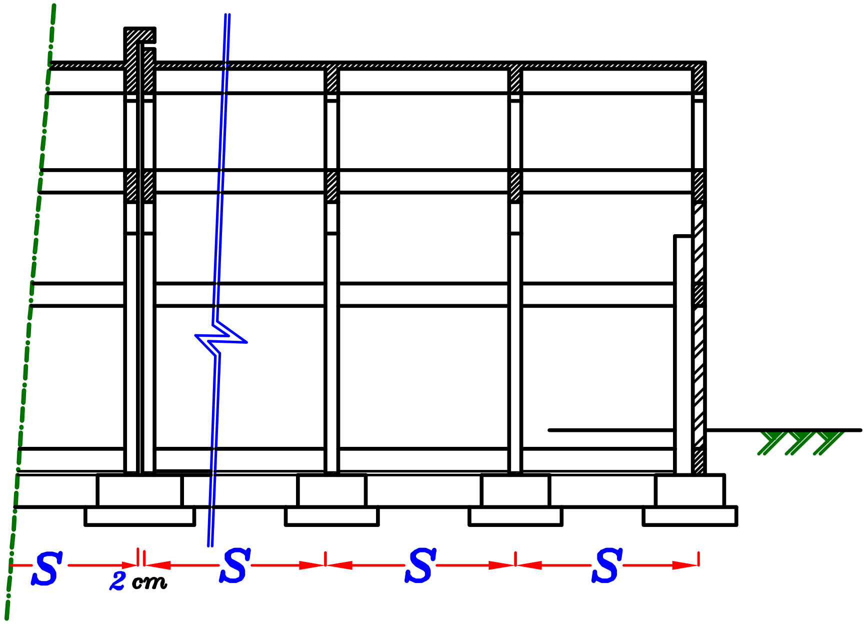
$A_{S1} - A_{S2}$
A_{S2}
Stirrup Hangers
$(0.1 \rightarrow 0.2)$ A_S
Stirrup Hangers $\simeq 0.4\ A_{S2}$
$\frac{1}{2}\ A_{S2}$
$\frac{1}{2}\ A_{S2}$
A_{S1}
$(0.1 \rightarrow 0.2)$ A_{S1}
2 φ 10 at 30 cm
2 φ 10 at 30 cm
t
b
Sec. (1–1)
0.4 A_{S2}
2 φ 12\25 cm
2 φ 12\25 cm
2 φ 12\25 cm
A_{S2}
t
b
Sec. (2–2)

3 Hinged Frame with Sky Light.

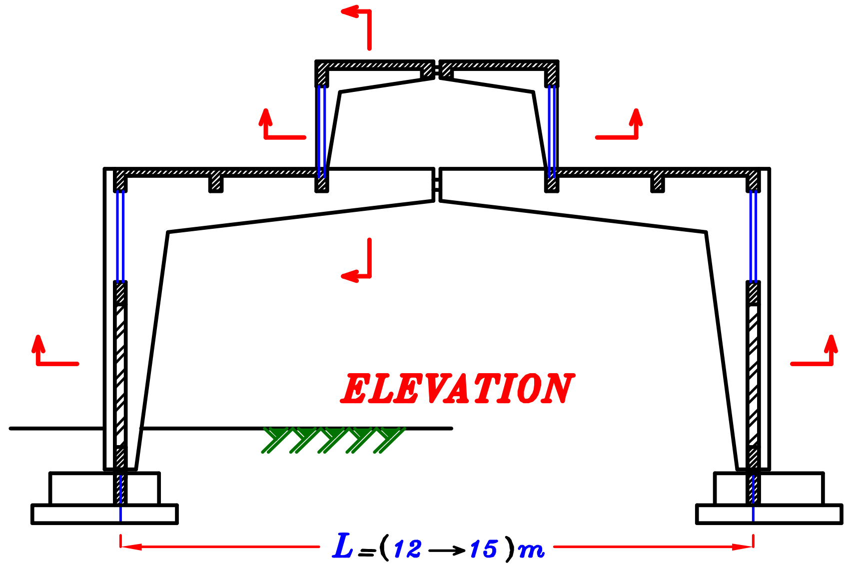


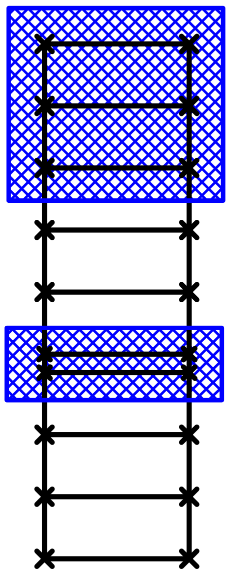
ELEVATION

3 Hinged Frame with Sky Light.



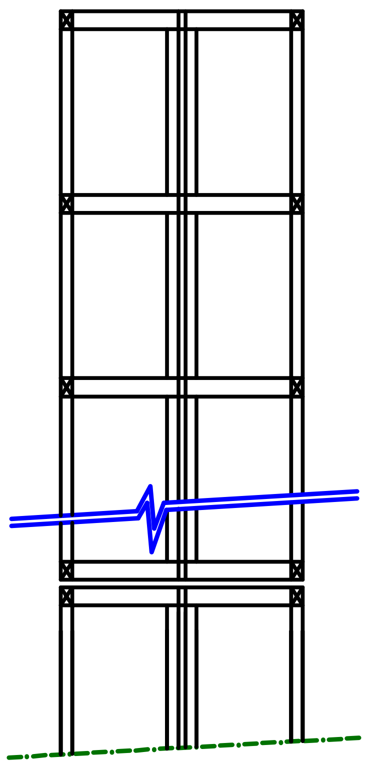
SIDE VIEW



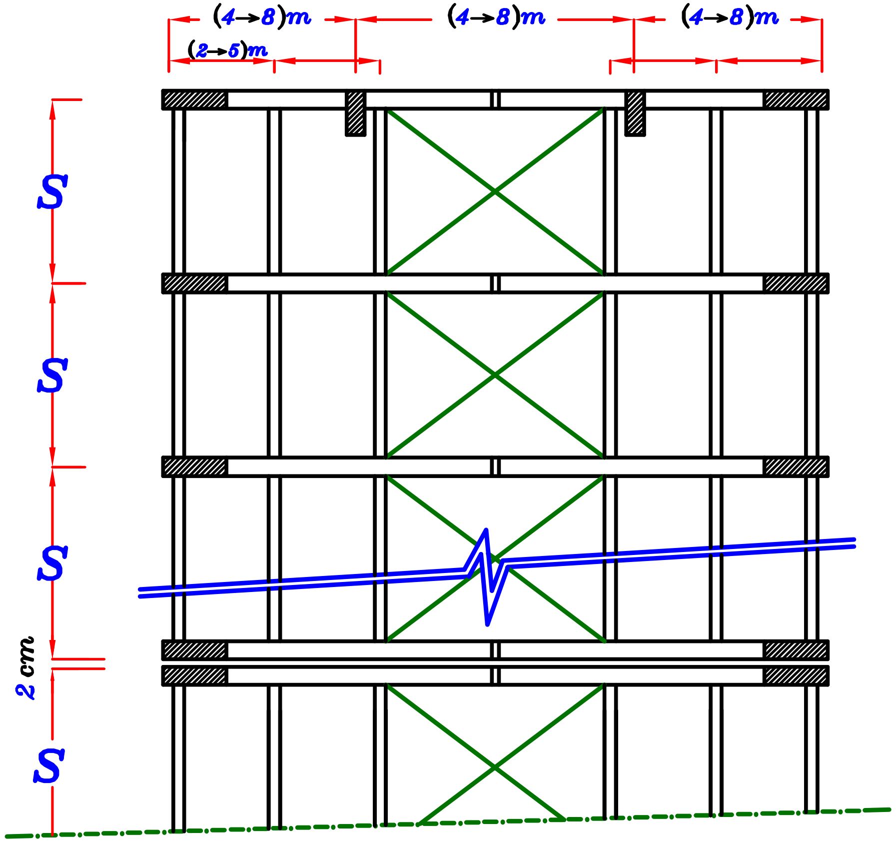


KEY PLAN

1:200 ⟶ 1:400

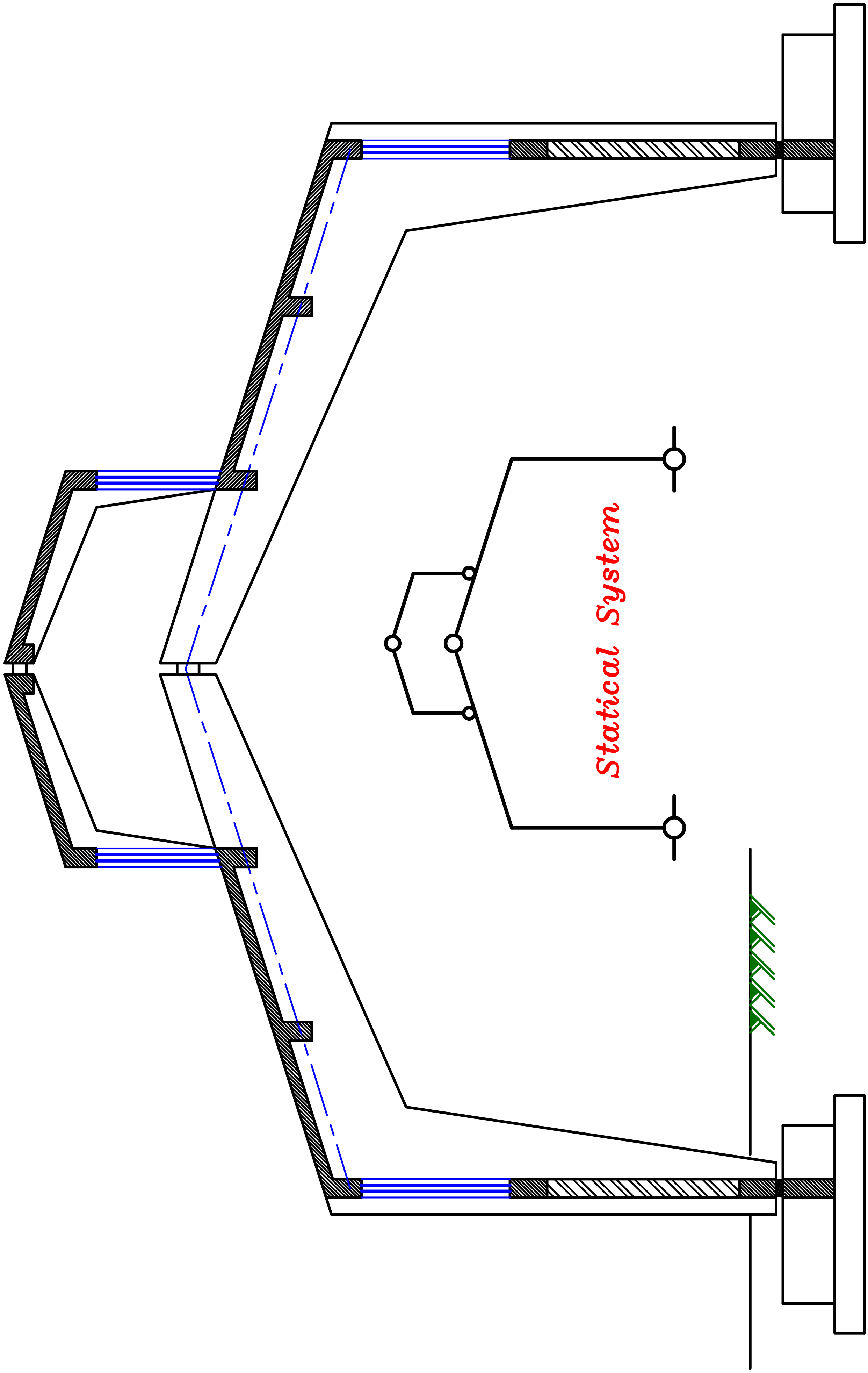


PLAN ②



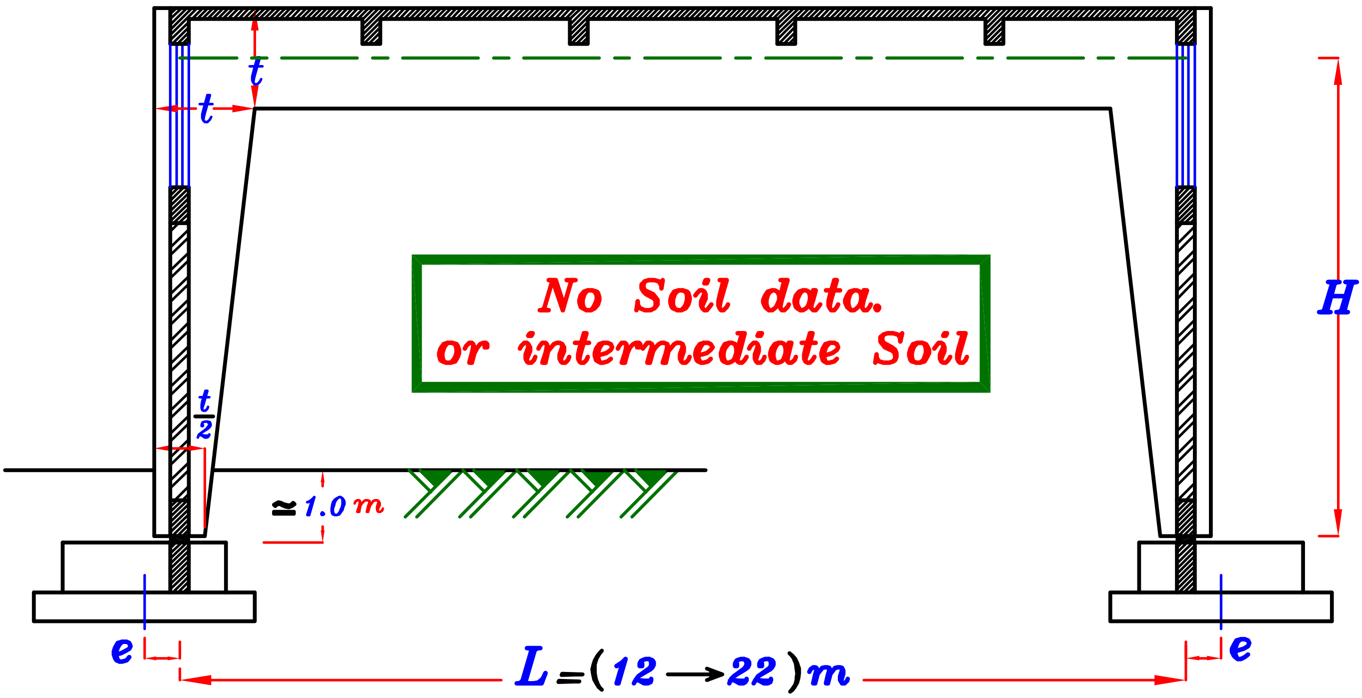
PLAN ①

Inclined 3 Hinged Frame with Sky Light.



ELEVATION

Two Hinged Straight Frame.



– Statical System

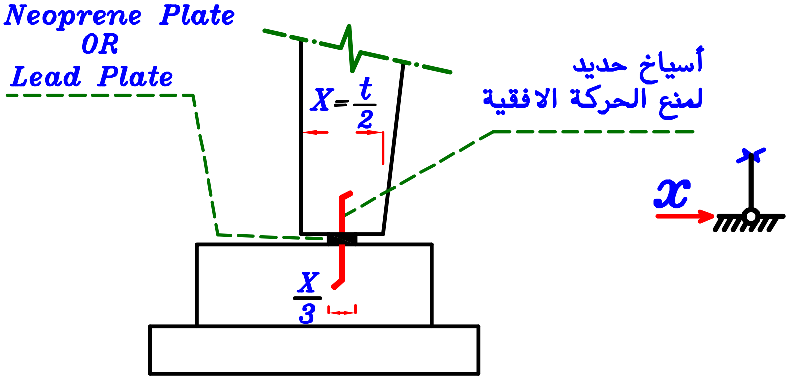
The 2 hinged Frame is
Once Statically indeterminate structure

– Concrete Dimensions.

$* \ Span\ (L) = (12 \rightarrow 22)\ m$

$* \ t \simeq \dfrac{L}{12 \rightarrow 14}$

$* \ b = \left.\begin{array}{l} 0.30\ m \\ \dfrac{Spacing}{20} \end{array}\right\}$ الأكبر

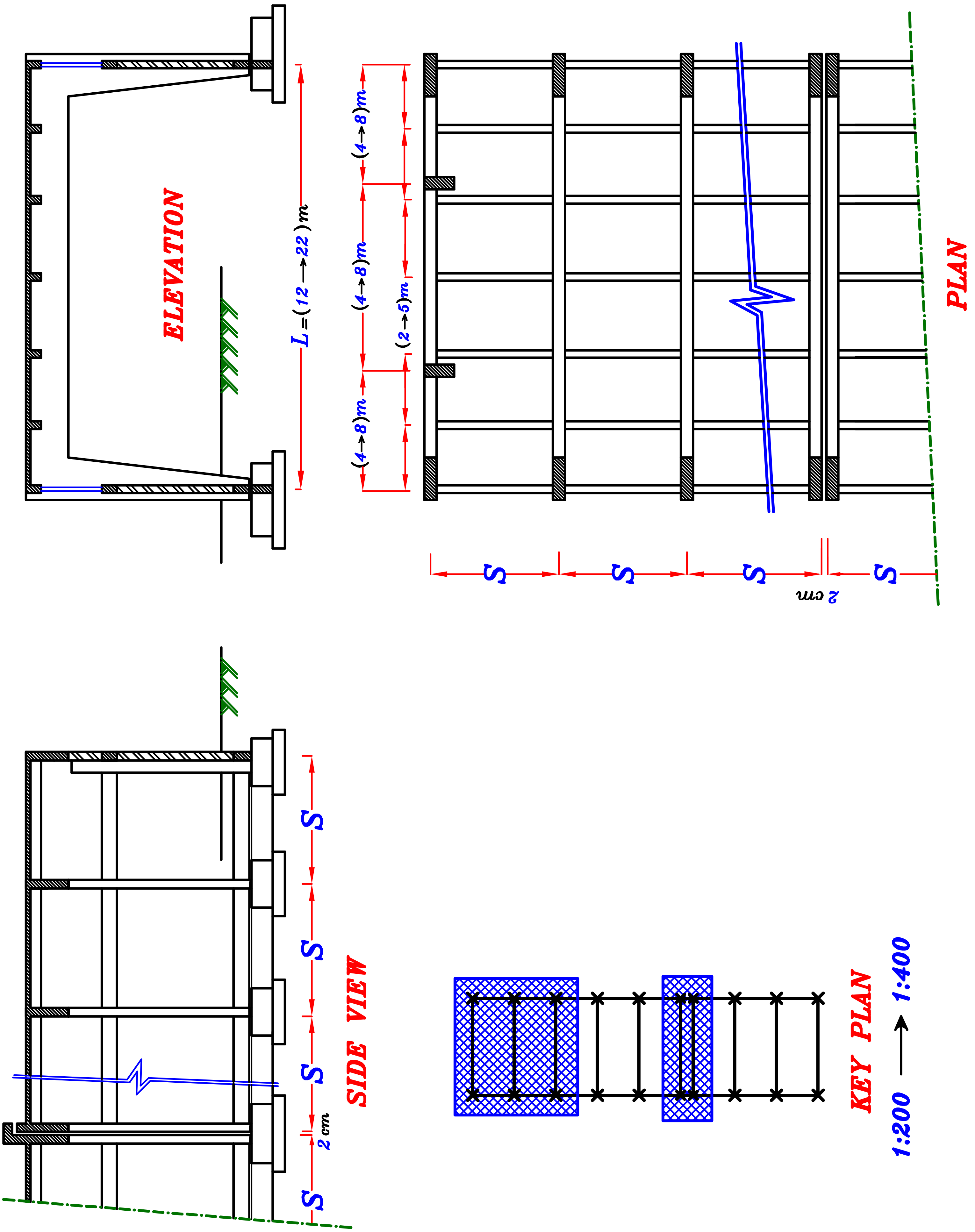


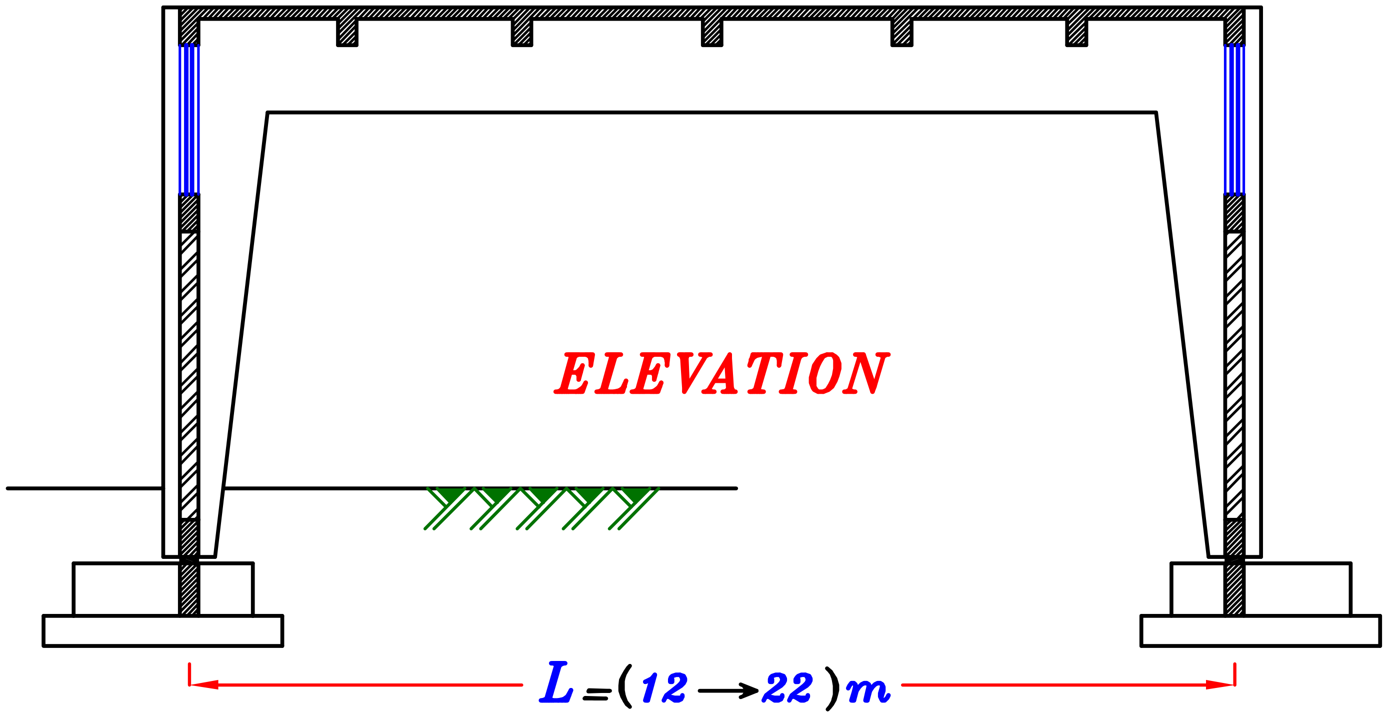
– القواعد عباره عن **Real Hinge**

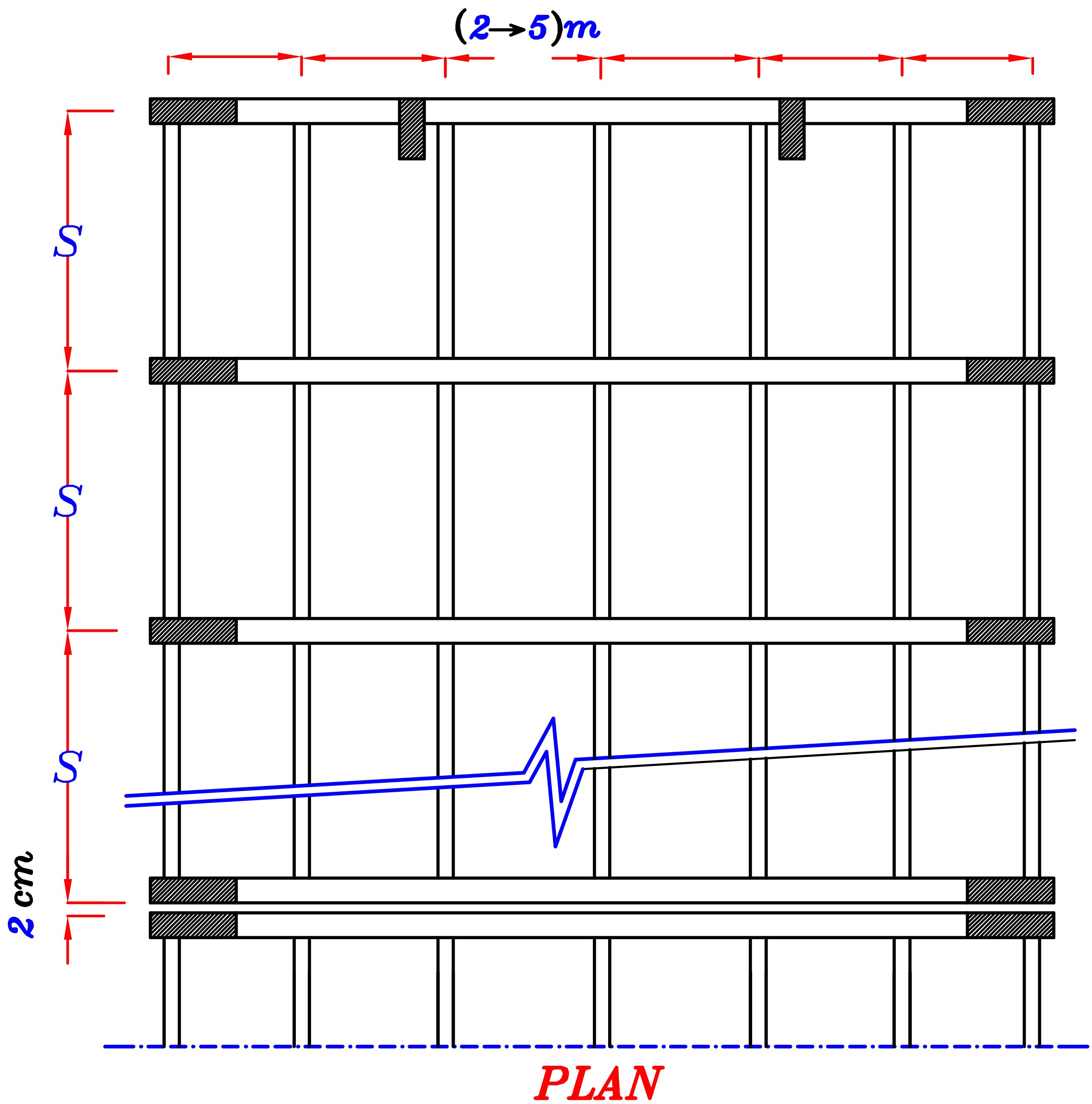
ترحل القواعد عكس إتجاه الـ (x)

أى ترحل القواعد للخارج مسافه (e)

لعمل **uniform stress** على التربه


ELEVATION
L=(12→22)m
(4→8)m
(4→8)m
(4→8)m
(2→5)m
PLAN
S
S
S
S
2 cm
SIDE VIEW
S
S
S
S
2 cm
KEY PLAN
1:200 → 1:400


ELEVATION
L =(12 ⟶ 22)m


(2→5)m
S
S
S
2 cm
PLAN

Steps of Design.

خطوات المسأله .

١- اختيار ال system

٢- رسم concrete Dim. فى ال elevation & Plan

٣- رسم تسليح البلاطه على نفس ال Plan

٤- عمل Load distribution للبلاطات و حساب الاحمال على ال System

٥ - حل ال System و رسم B.M.D. & N.F.D.

٦- تصميم قطاعات ال System على M,N

٧- رسم تسليح ال System فى ال elevation & cross-sec.

Moment Distribution Method.

ⓐ Get Moment of Inertia For all members. 《 I 》

ⓑ Get Distribution Factors at all Joints. 《 D.F. 》

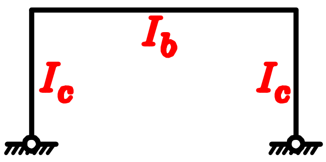
ⓒ Get Fixed End Moments For Beams. 《 F.E.M. 》

ⓓ Get the Final Moment. 《 M_F 》

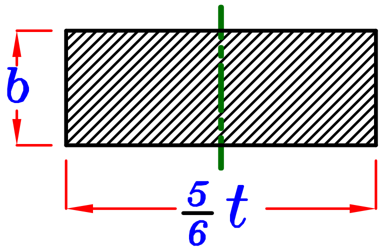
ⓔ Get B.M.D. , N.F.D. , S.F.D.

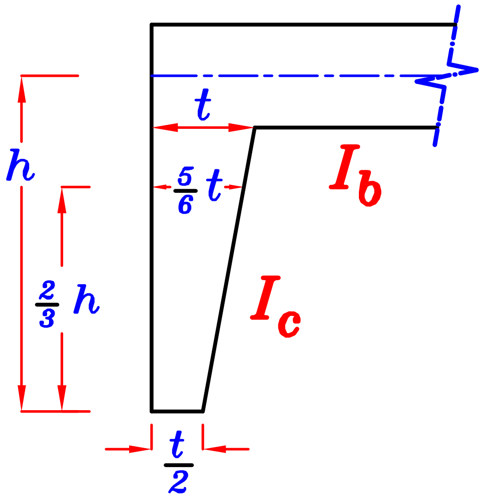
1- Calculate Moment of Inertia For members.

* For Column.

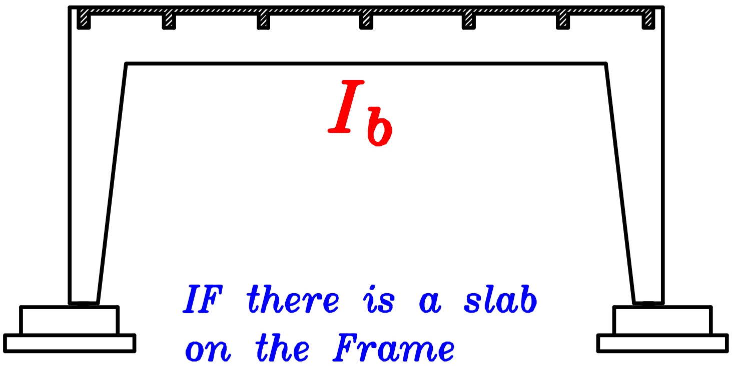


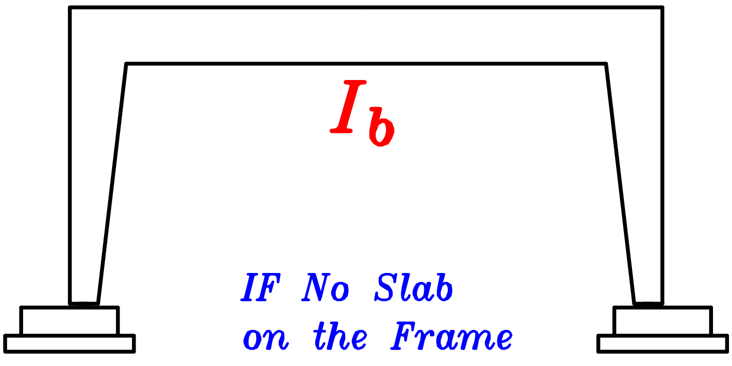
$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12}$$





* For Beams.

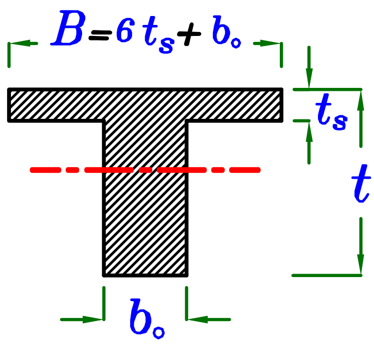




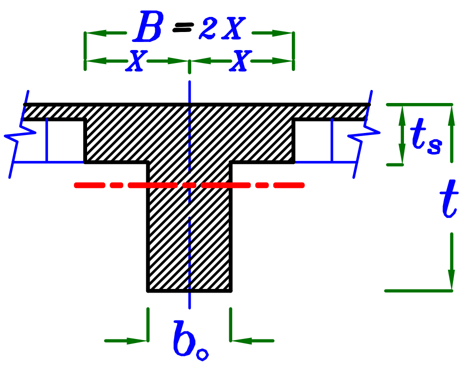
① IF there is a slab on the Frame.

$$I_b = (\mu \times 10^{-4})\ B\ t^3$$

old Tables page 91



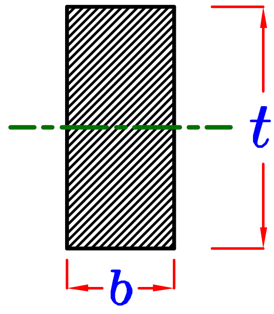
For Solid slab.



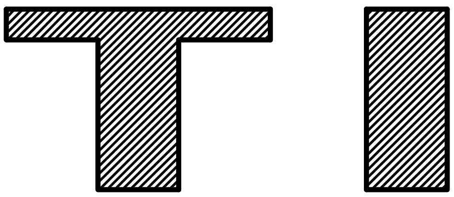
For H.B. slab.

② IF there is no slab on the Frame.

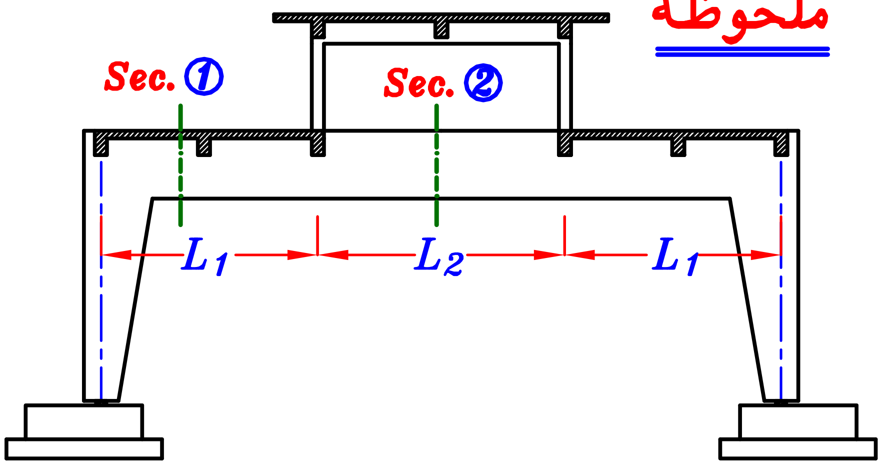
$$\boxed{I_b = \frac{b(t)^3}{12}}$$



ملحوظه



Sec. ①　　Sec. ②



عند وجود شخشيخة يوجد قطاعان فى كمره ال Frame

نأخذ المتوسط

$$\boxed{I_b = \frac{I_{b1} * 2L_1 + I_{b2} * L_2}{2L_1 + L_2}}$$

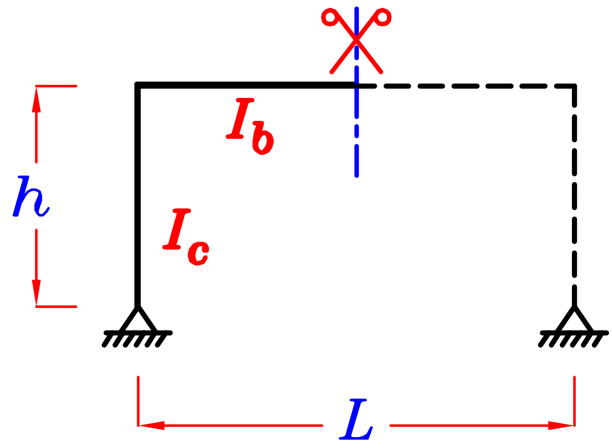
2- Get the Distribution Factor.

$$K_b = \frac{1}{2}\,\frac{I_b}{L}$$

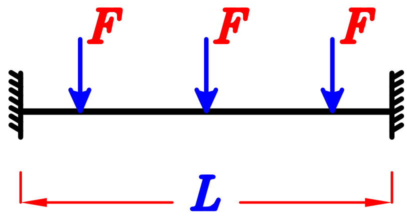
$$K_c = \frac{3}{4}\,\frac{I_c}{h}$$

$$D.F._c = \frac{K_c}{K_b + K_c}$$

$$D.F._b = \frac{K_b}{K_b + K_c}$$



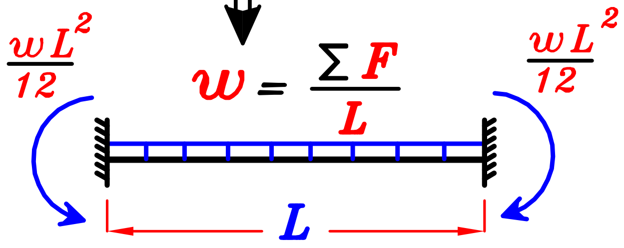
3- Get Fixed End Moment.

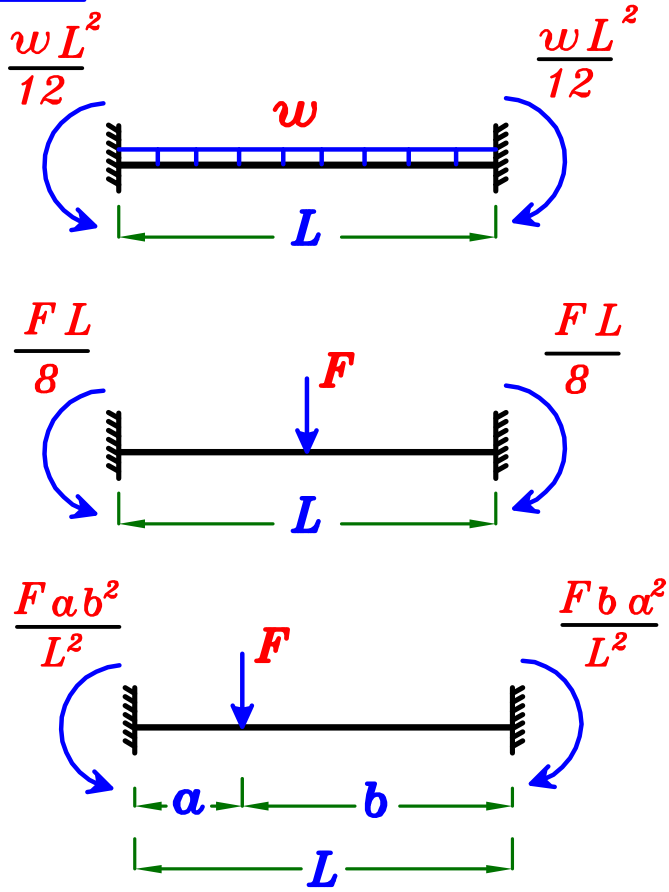


IF number of Loads $\geqslant$ 3

$$\Downarrow$$

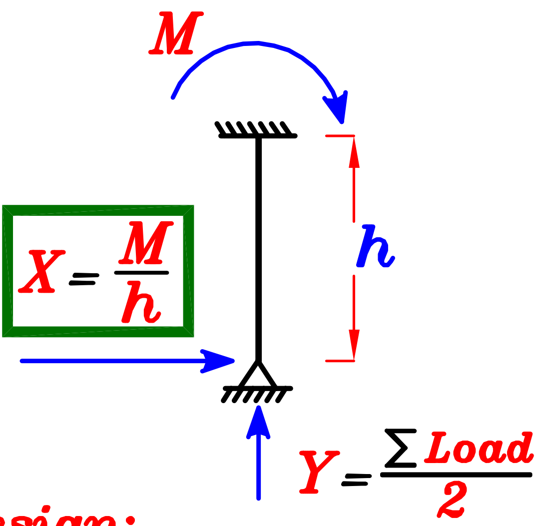
$$w = \frac{\sum F}{L}$$

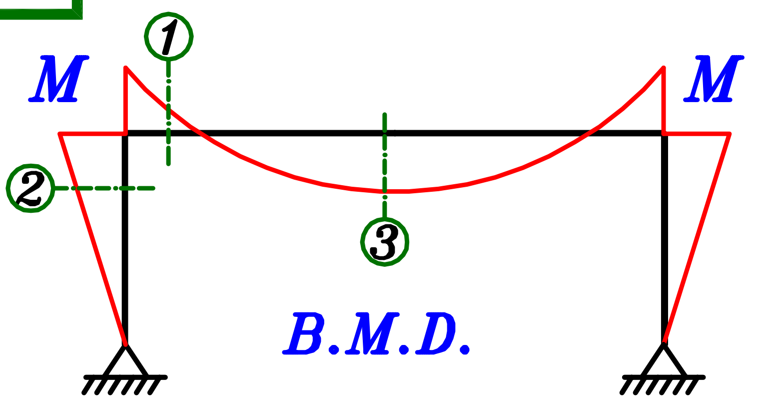




4- Calculate the moment.

$$\boxed{M = F.E.M.\,(Beam) * D.F.\,(Col.)}$$





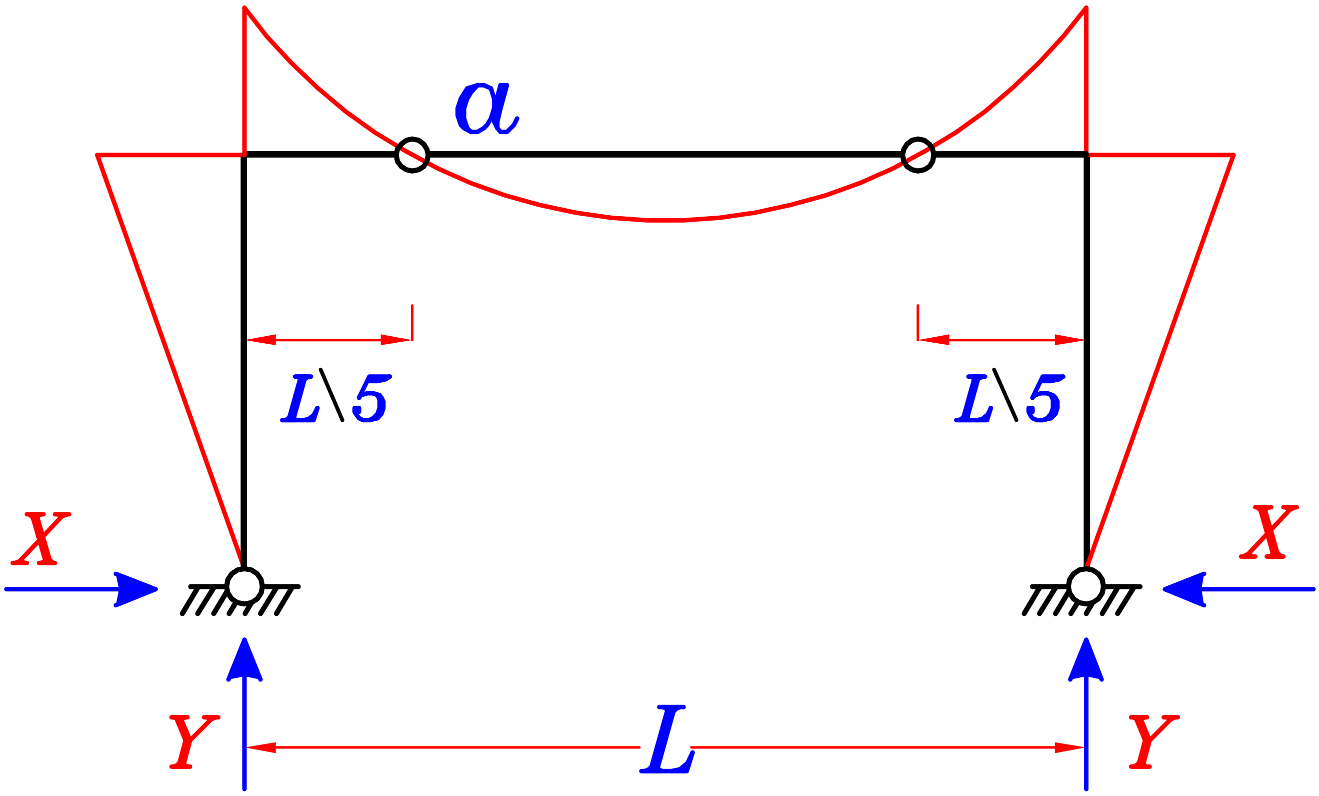
Design:

Sec. 1 on M , P R_Sec.

Sec. 2 on M , P R_Sec.

Sec. 3 on M , P T_Sec.

Approximate Solution.



assume that in the beam there is an intermediate hinge at $\frac{L}{5}$

$$Y = \frac{\sum Loads}{2}$$

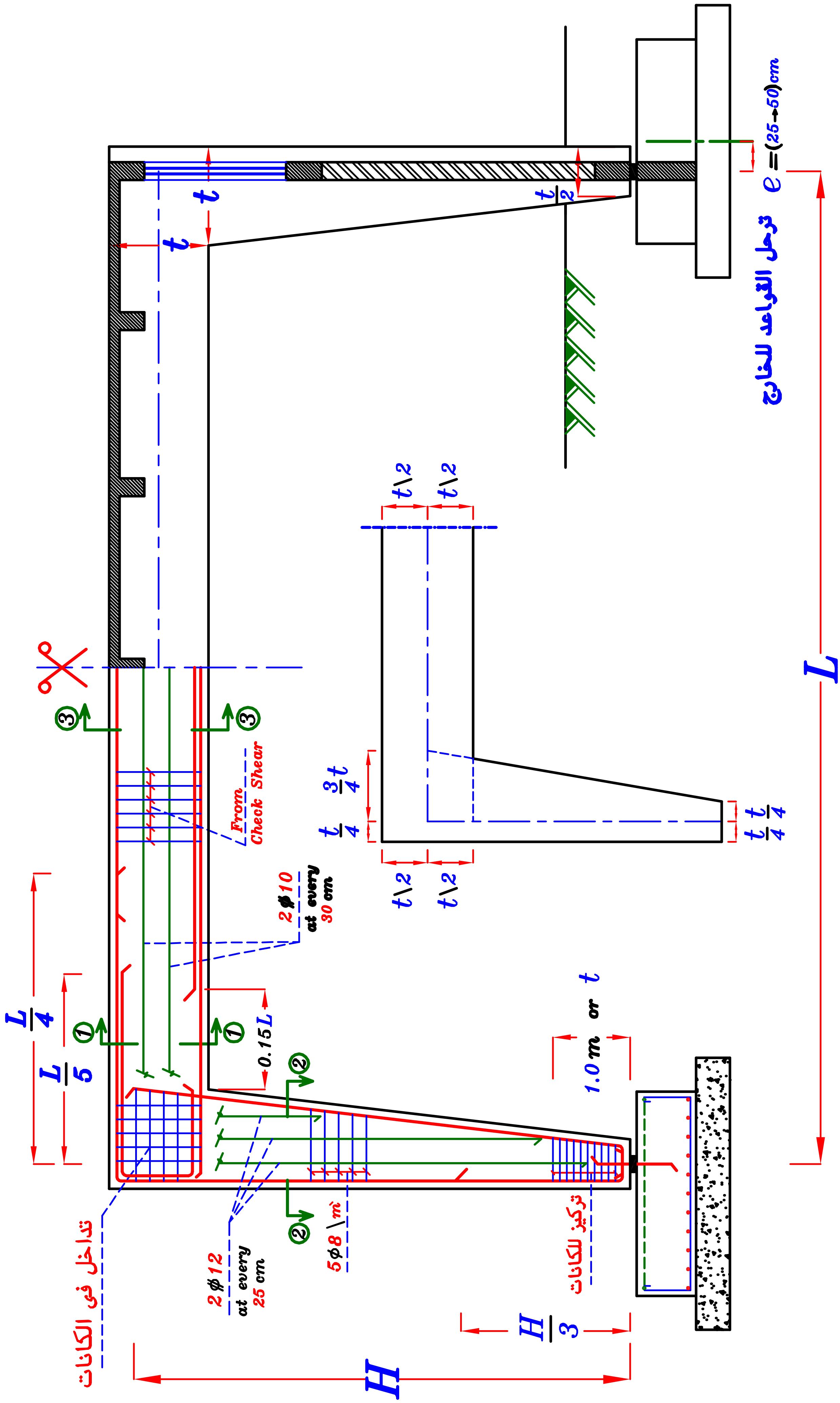
To get the reactions X

Take the moment at Point a = Zero

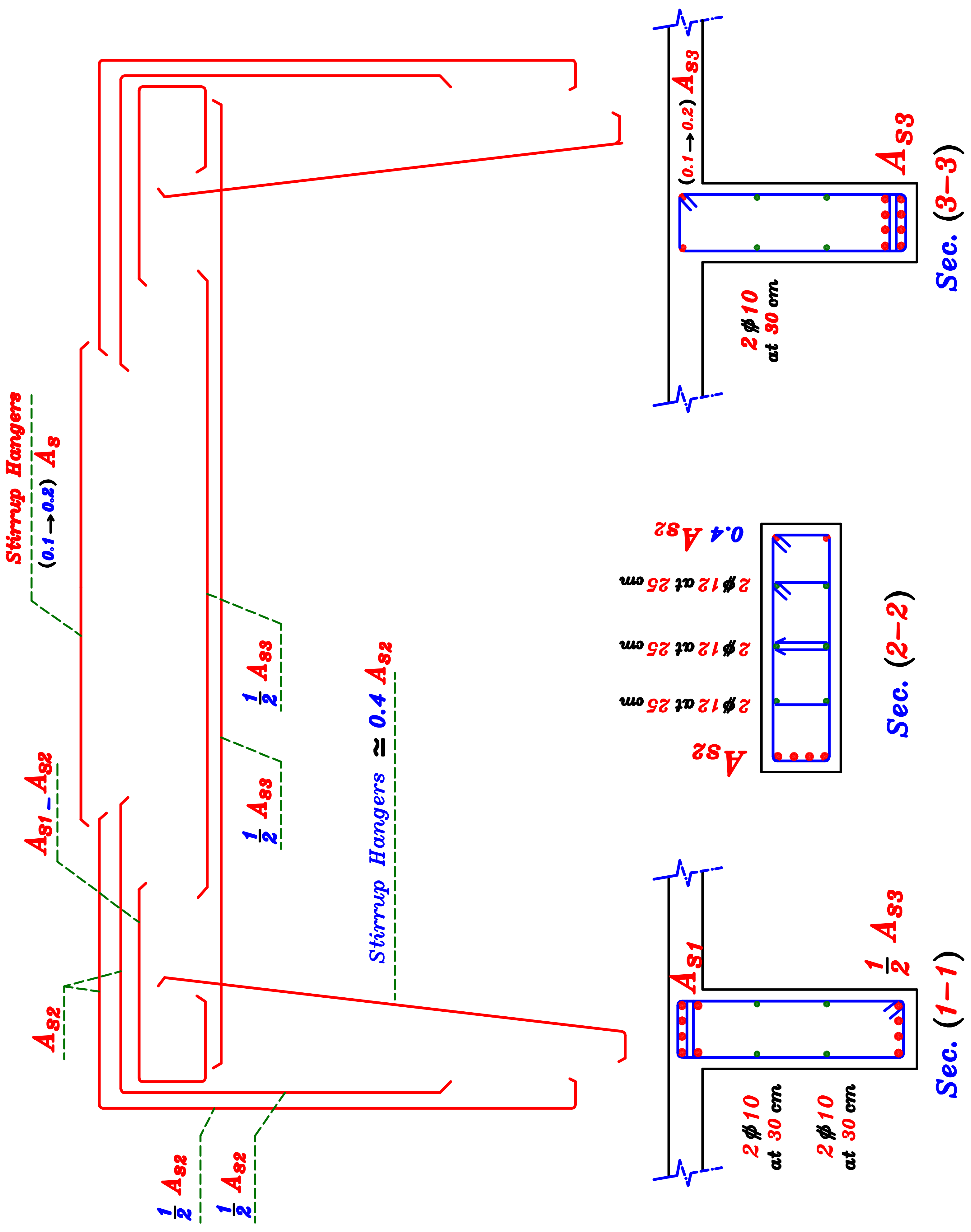
Then Draw Internal Forces Diagrams.

ملحوظه هامه

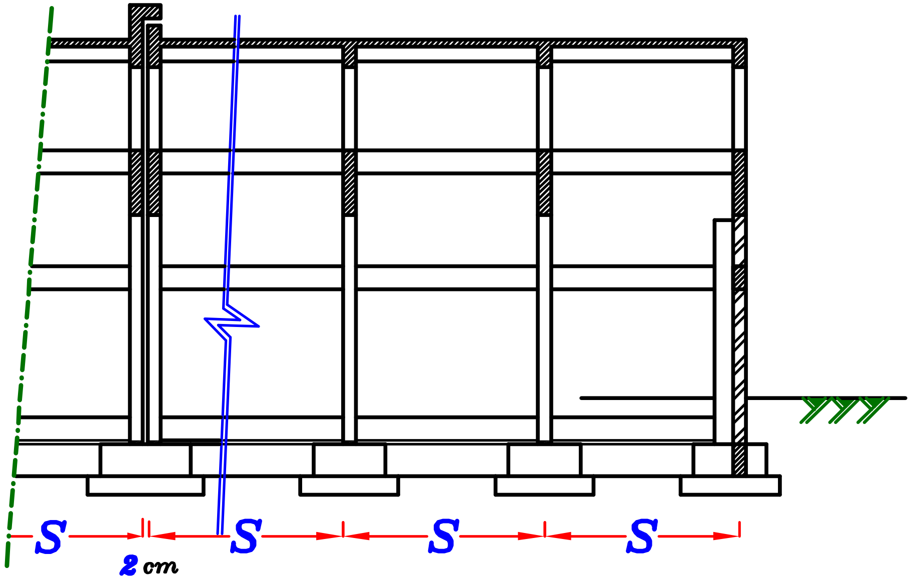
هذا الحل حل تقريبى جدا و غير دقيق ، لذا لن نستخدم هذا الحل
الا مع تعذر الوقت فى الامتحان



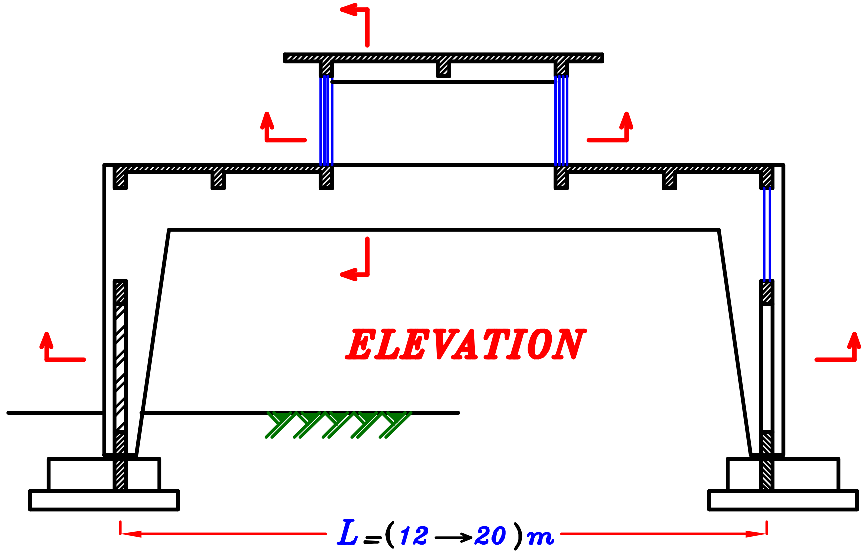
ترحيل القواعد للخارج
e =(25→50)cm
t
t/2
L
t\2
3t/4
t/4
From Check Shear
2φ10 at every 30 cm
L/4
L/5
0.15L
1.0 m or t
2φ12 at every 25 cm
5φ8 \m'
تداخل فى الكانات
تركيز للكانات
H/3
H

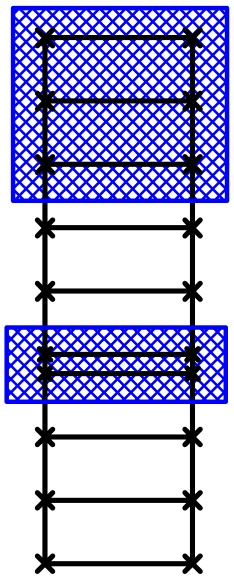

Stirrup Hangers
(0.1 → 0.2) As
As1 _ As2
As2
1/2 As2
1/2 As2
1/2 As3
1/2 As3
Stirrup Hangers ≃ 0.4 As2
As1
1/2 As3
2 φ10 at 30 cm
2 φ10 at 30 cm
Sec. (1-1)
As2
2 φ12 at 25 cm
2 φ12 at 25 cm
2 φ12 at 25 cm
0.4 As2
Sec. (2-2)
(0.1 → 0.2) As3
As3
2 φ10 at 30 cm
Sec. (3-3)

2 Hinged Frame with Sky Light.



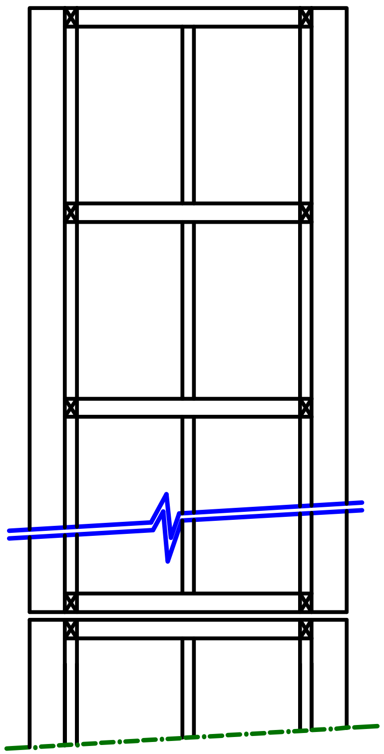
SIDE VIEW



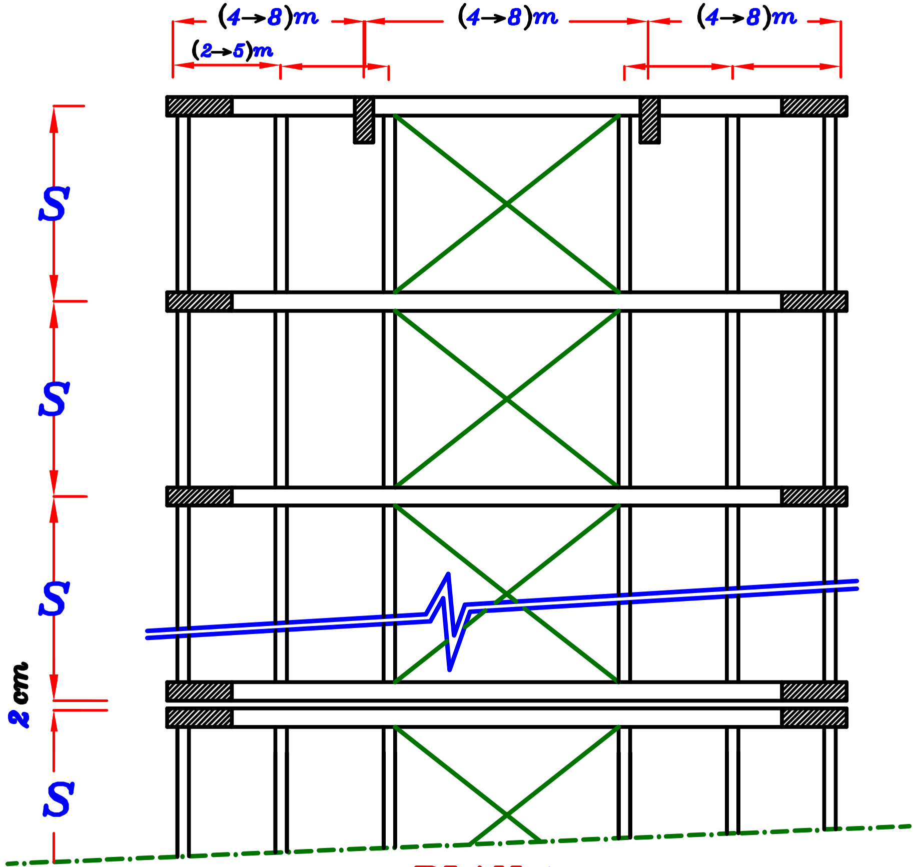


KEY PLAN

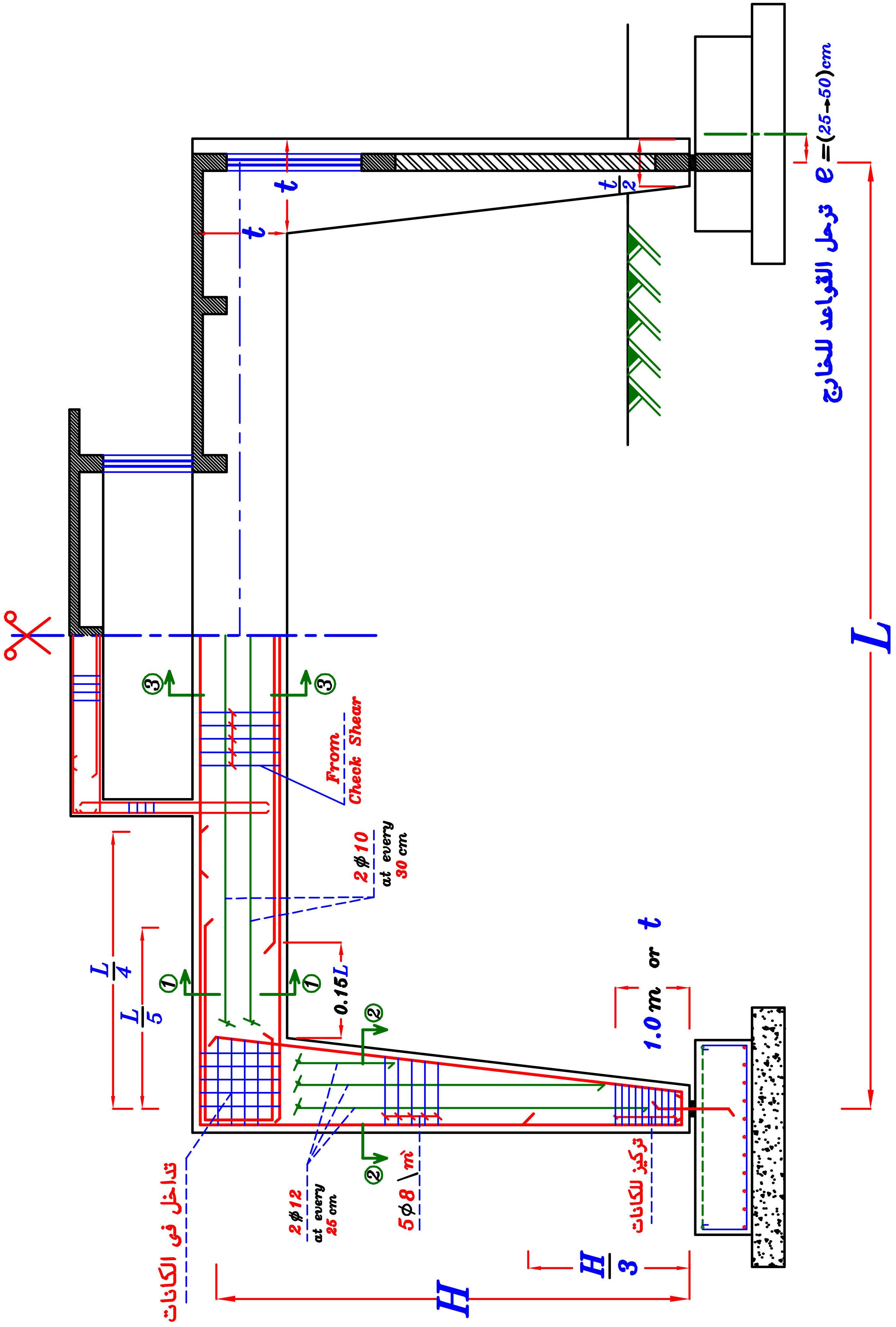
1:200 → 1:400



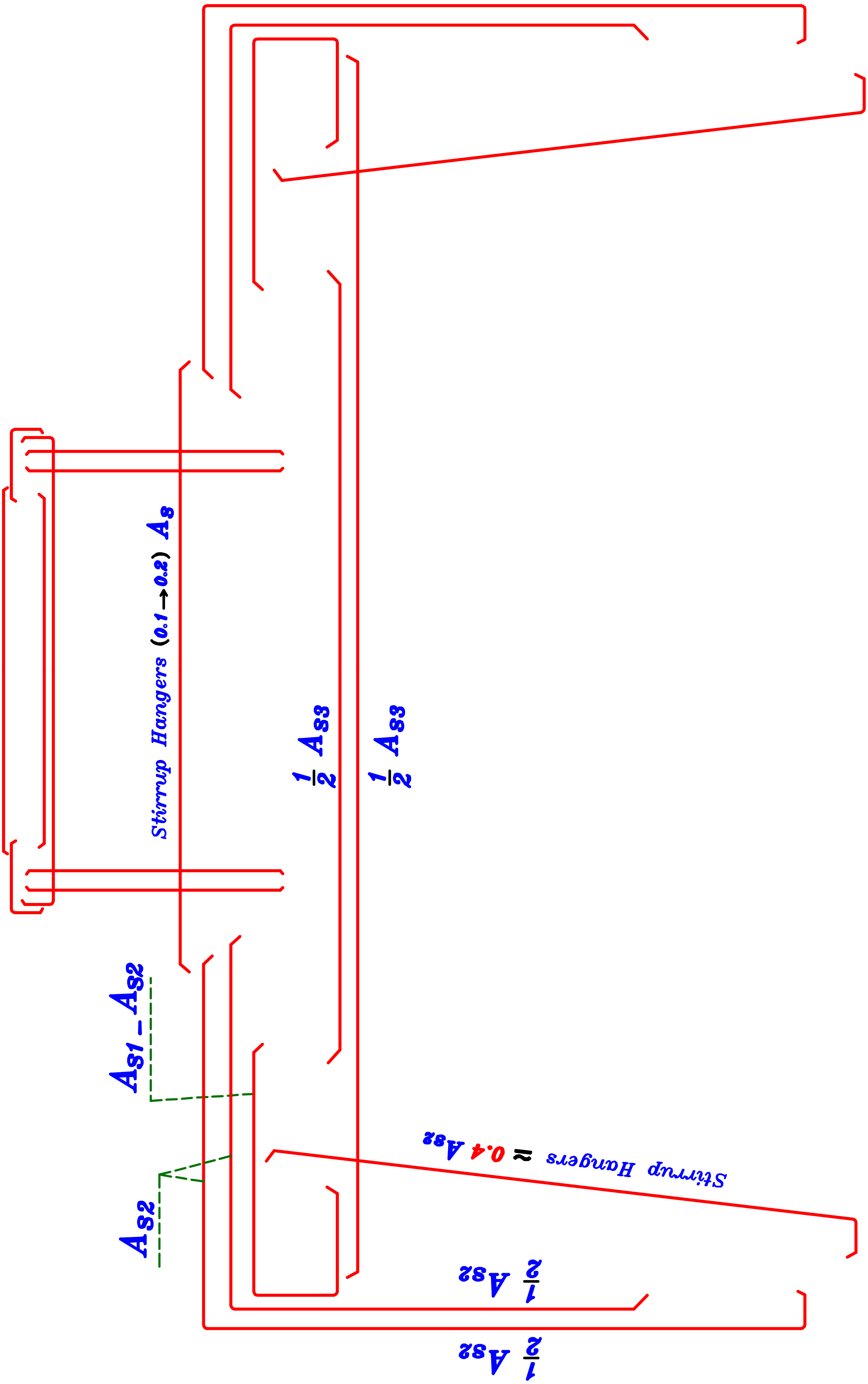
PLAN ②



PLAN ①



e =(25→50)cm
ترحل القواعد للخارج
L
t
t
t/2
From
Check Shear
2φ10
at every
30 cm
0.15L
L/4
L/5
1.0 m or t
H/3
H
تداخل فى الكانات
2φ12
at every
25 cm
5φ8 \ m'
تركيز للكانات


Stirrup Hangers (0.1→0.2) As
1/2 As3
1/2 As3
As1 - As2
As2
Stirrup Hangers ≈ 0.4 As2
1/2 As2
1/2 As2

Example.

$F_{cu} = 25 \quad N\backslash mm^2 \qquad F_y = 360 \quad N\backslash mm^2$

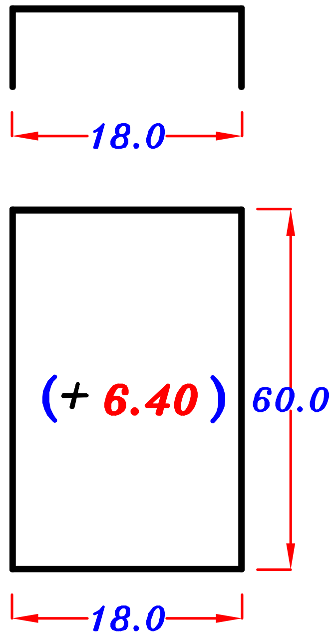
$L.L. = 1.0 \quad kN\backslash m^2 \qquad F.C. = 2.0 \quad kN\backslash m^2$

Slab Level $= (+6.40)$ m

Foundation Level. $= -2.5$ m

Window height $= 1.5$ m

Spacing $= 6.5$ m



Req.

1- Choose a suitable system to cover this area & draw concrete dimensions in elevation For the main supporting element.

2- Design the main supporting element & draw its details of RFT.

خطوات المسأله

١ - اختيار الـ system

٢ - رسم concrete Dim. فى الـ elevation & Plan

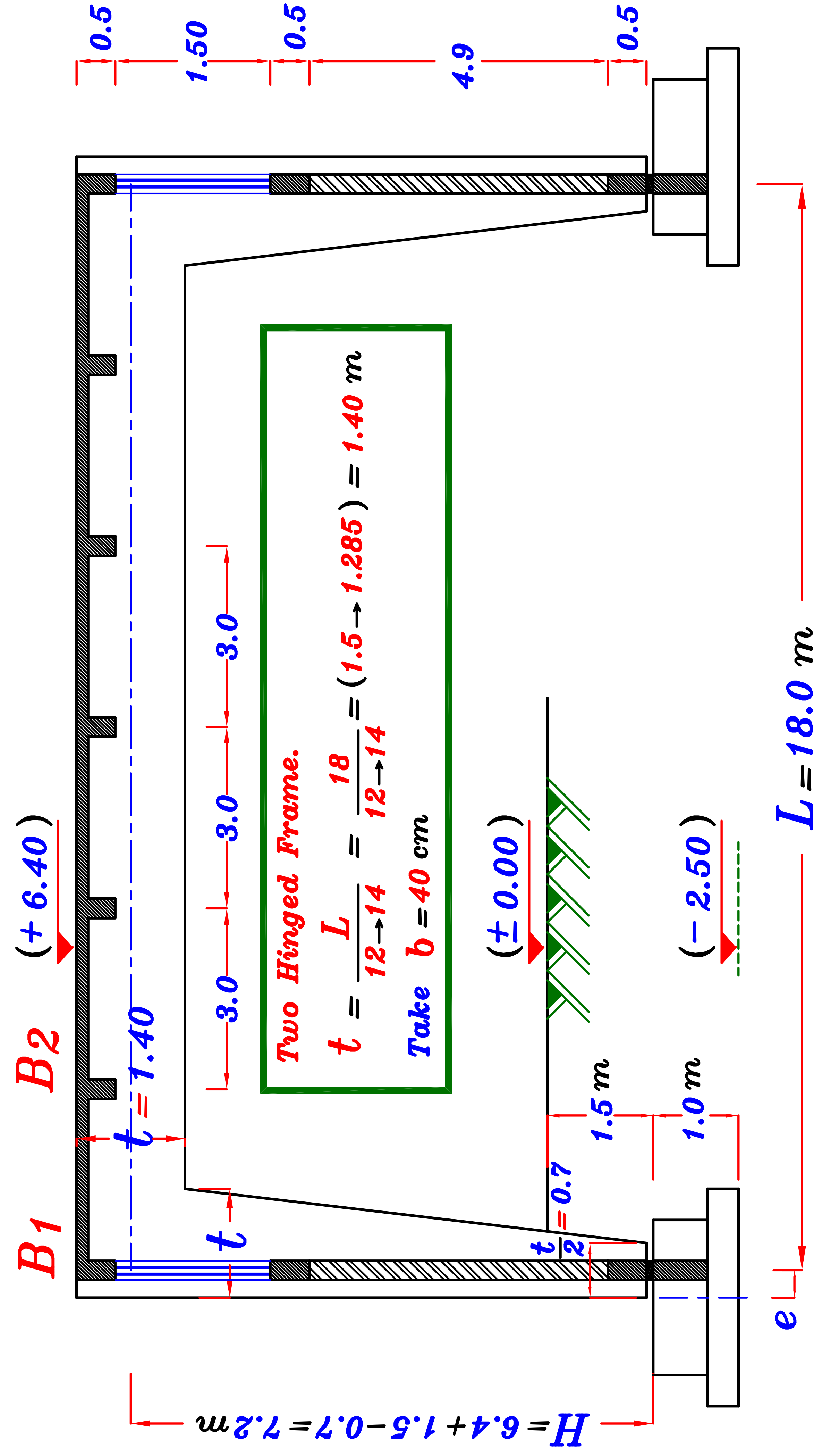
٣ - رسم تسليح البلاطه على نفس الـ Plan

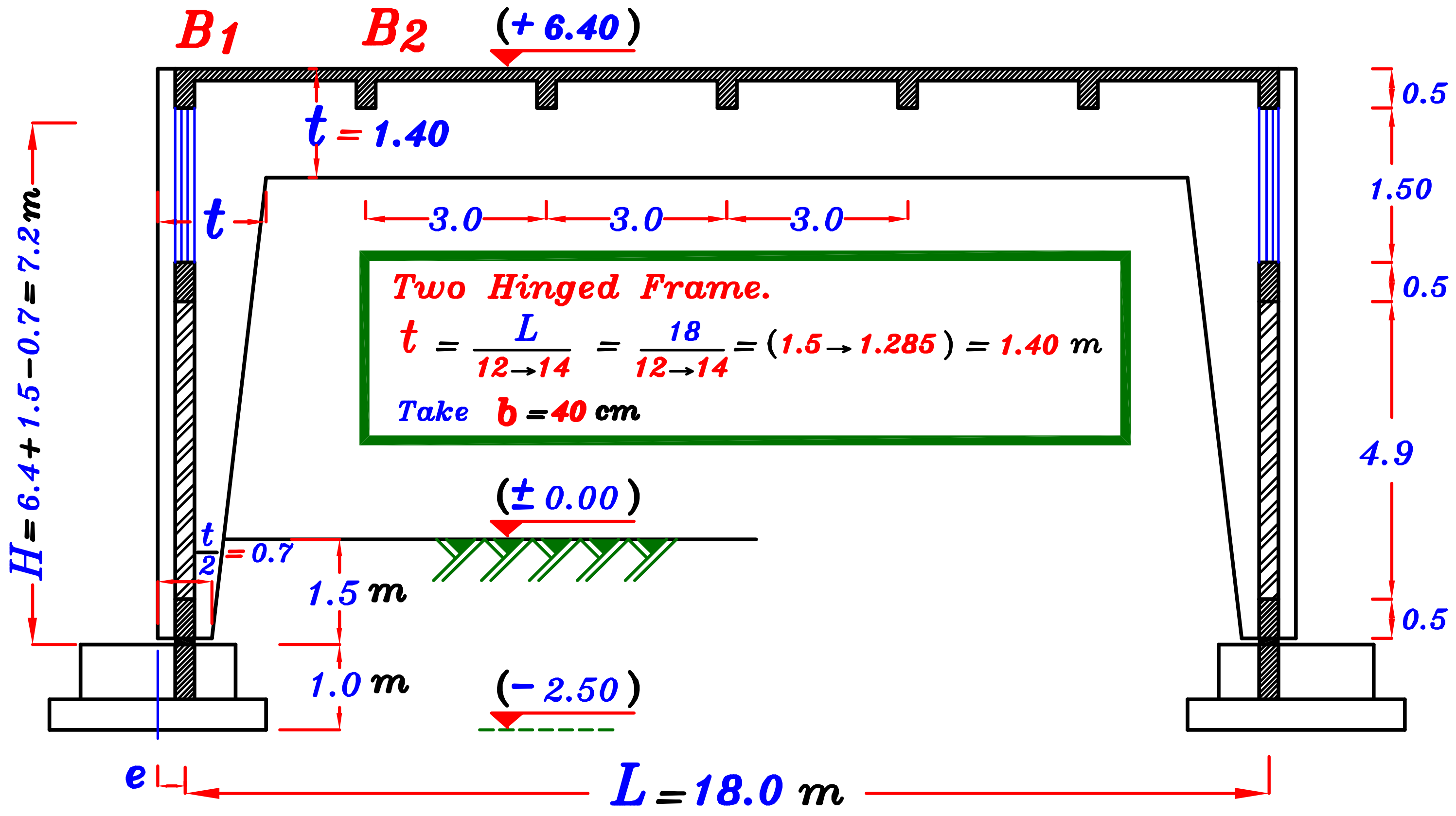
٤ - عمل Load distribution للبلاطات و حساب الاحمال على الـ System

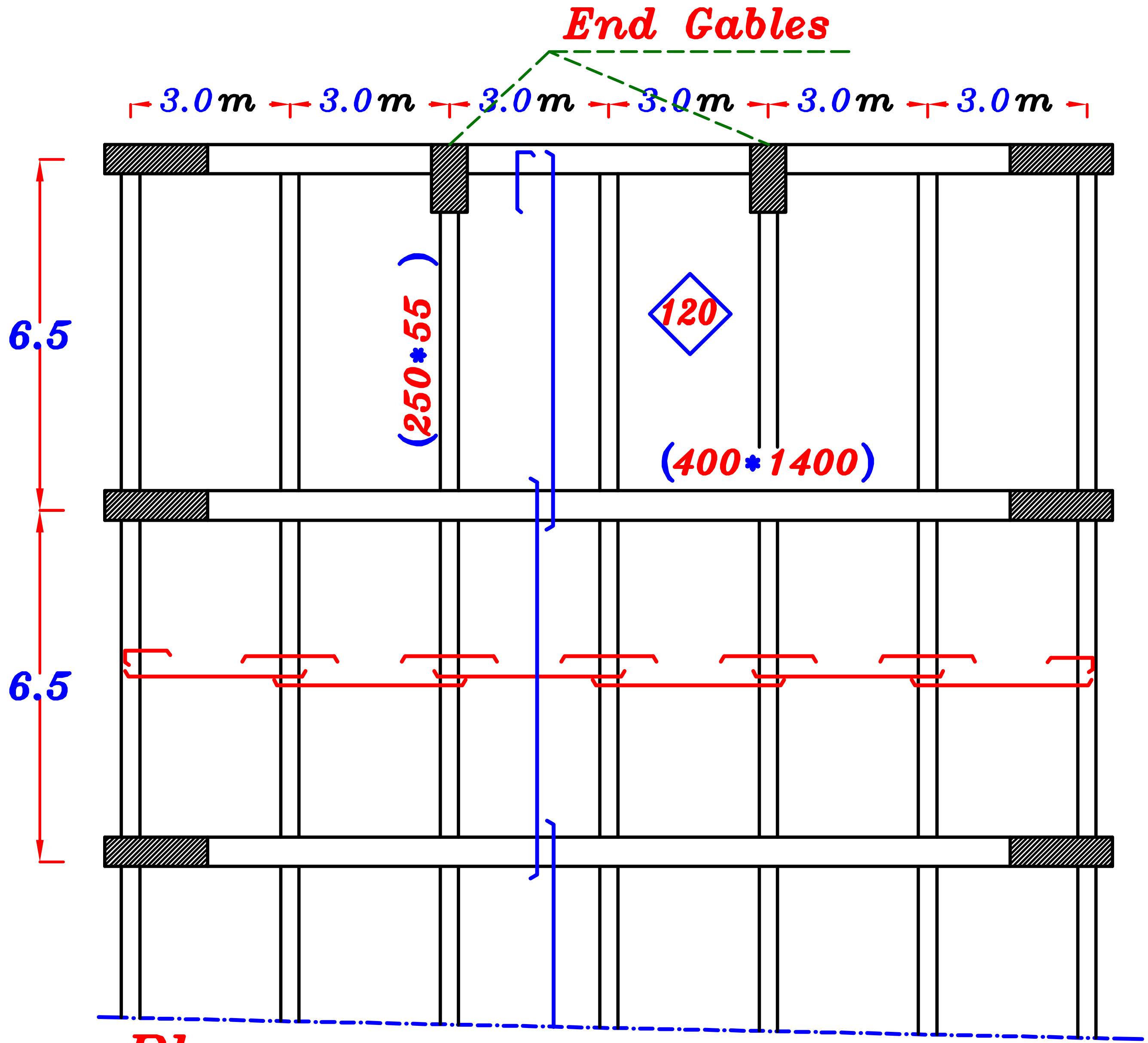
٥ - حل الـ System و رسم B.M.D. & N.F.D.

٦ - تصميم قطاعات الـ System على M,N

٧ - رسم تسليح الـ System فى الـ elevation & cross-sec.

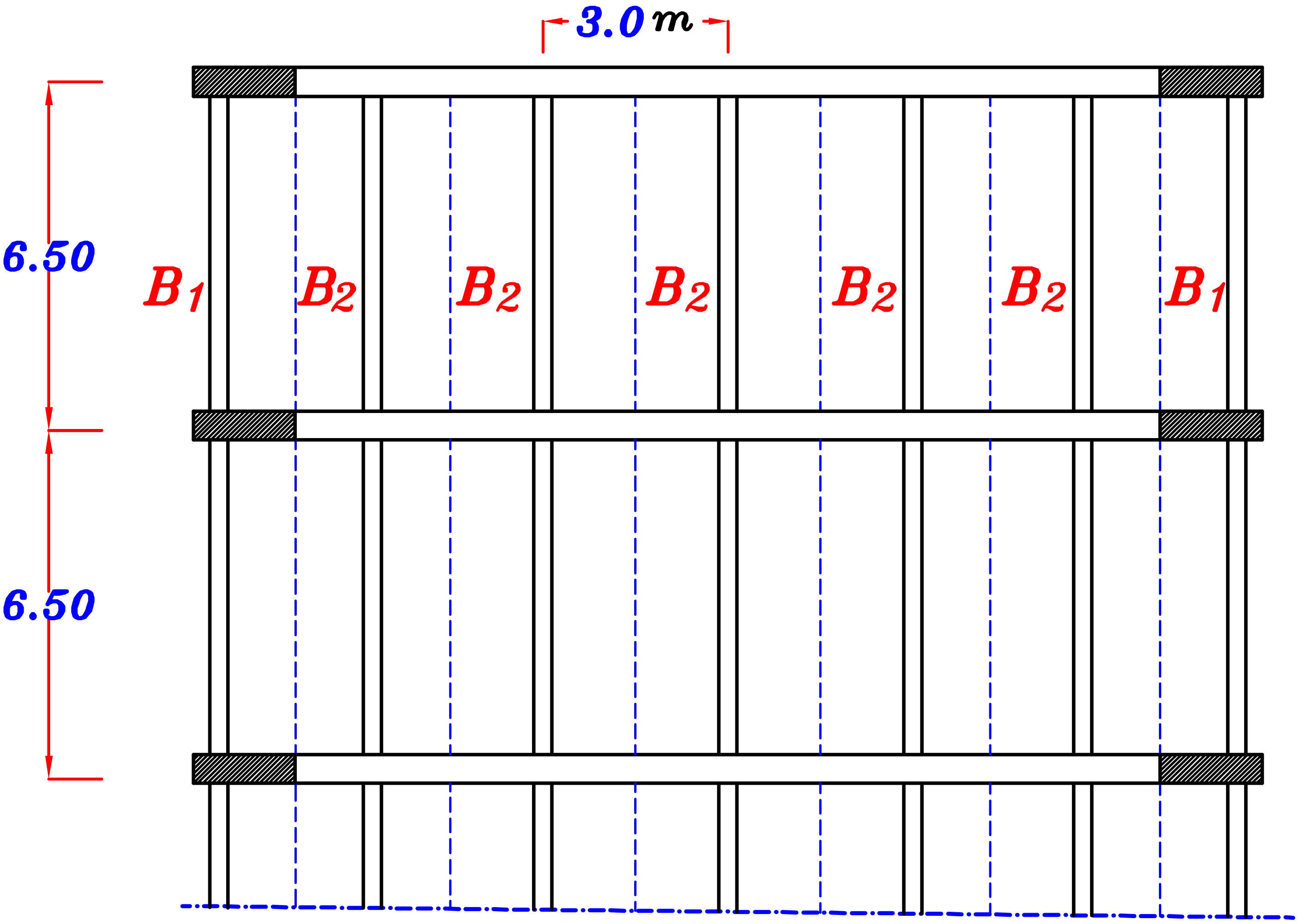

Two Hinged Frame.
t = L / (12→14) = 18 / (12→14) = (1.5→1.285) = 1.40 m
Take b = 40 cm
L = 18.0 m
H = 6.4 + 1.5 − 0.7 = 7.2 m
(+ 6.40)
(± 0.00)
(− 2.50)
B1
B2
t = 1.40
t
t/2 = 0.7
e
3.0
3.0
3.0
0.5
1.50
0.5
4.9
0.5
1.5 m
1.0 m


B1
B2
(+ 6.40)
t = 1.40
t
3.0
3.0
3.0
Two Hinged Frame.
t = L / 12→14 = 18 / 12→14 = (1.5→1.285) = 1.40 m
Take b = 40 cm
(± 0.00)
t/2 = 0.7
1.5 m
1.0 m
(− 2.50)
H = 6.4+1.5−0.7 = 7.2 m
0.5
1.50
0.5
4.9
0.5
e
L = 18.0 m


End Gables
3.0 m
3.0 m
3.0 m
3.0 m
3.0 m
3.0 m
6.5
6.5
(250*55)
120
(400*1400)

Plan

Load Distribution on Beams.



One way Slab $t_s = \frac{300}{30} = 100\ mm$ **Take** $\boxed{t_s = 120\ mm}$

$w_s = 1.4\,(0.12 * 25 + 2.0) + 1.6\,(1.0) = 8.60\ kN\backslash m^2$

B_1

Take $o.w.(U.L.) = 3.0 * 1.4 = 4.20\ kN\backslash m$

$w_a = o.w. + w_s \frac{L_s}{2} = 4.20 + (8.60)\,(\frac{3}{2}) = 17.1\ kN\backslash m$

$R_1 = 17.1 * 6.5 = 111.15\ kN$ $\boxed{R_1 = 111.15\ kN}$

B_2

$w_a = o.w. + 2 w_s \frac{L_s}{2} = 4.20 + 2\,(8.60)\,(\frac{3}{2}) = 30.0\ kN\backslash m$

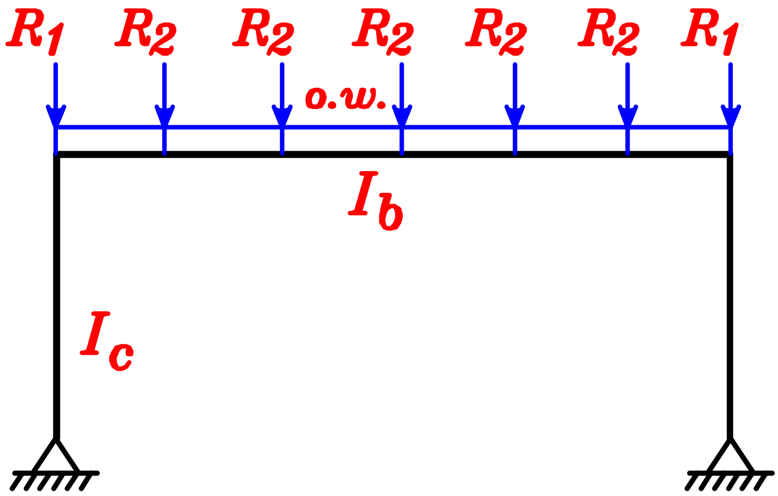
$R_2 = 30.0 * 6.5 = 195.0\ kN$ $\boxed{R_2 = 195.0\ kN}$

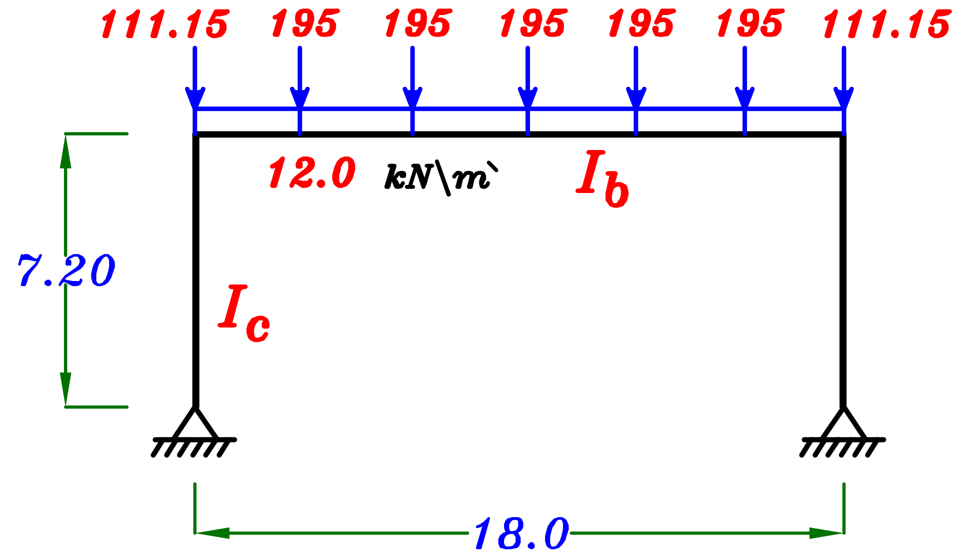
Loads on Frame.

Take

o.w.(U.L.)

$= 12.0 \ kN\backslash m'$

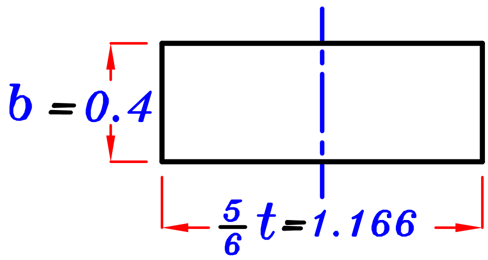




I_c

$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12} = \frac{0.4\left(\frac{5}{6} * 1.40\right)^3}{12}$$

$$= 0.05293 \ m^4$$

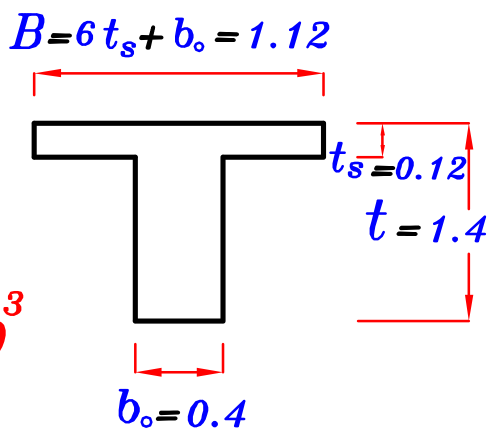


$$\frac{t_s}{t} = \frac{0.12}{1.40} = 0.085$$

$$\frac{b_o}{B} = \frac{0.40}{1.12} = 0.36$$

From Tables page 91

$\mu = 398$



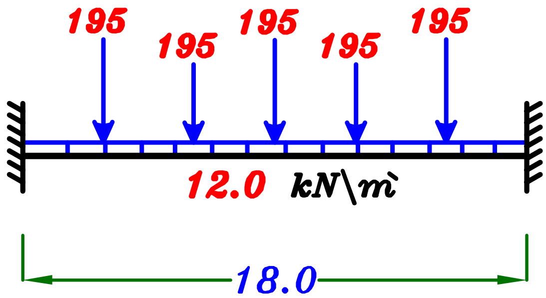
$$I_b = (\mu * 10^{-4})\, B t^3 = 398 * 10^{-4} * 1.12 * 1.40^3$$

$$0.1223 \ m^4$$

Using Moment Distribution.

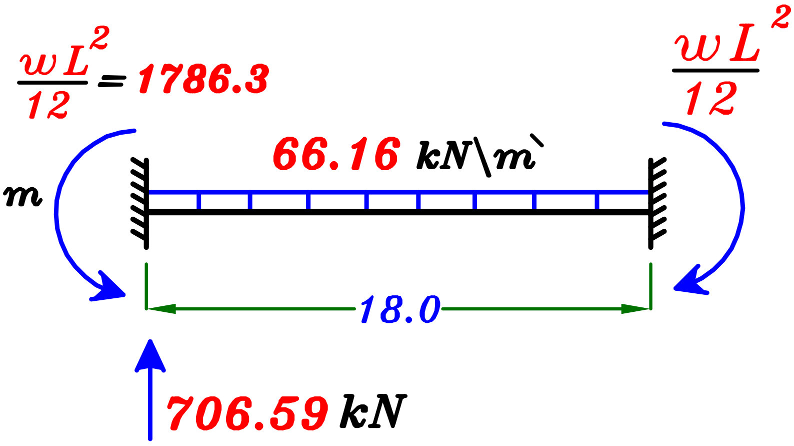
$$w = o.w. + \frac{\sum P}{span}$$

$$= 12.0 + \frac{5\,(195)}{18} = 66.16 \text{ kN}\backslash\text{m}'$$



F.E.M.

$$\frac{wL^2}{12} = \frac{66.16 * (18.0)^2}{12} = 1786.3 \text{ kN.m}$$



D.F.

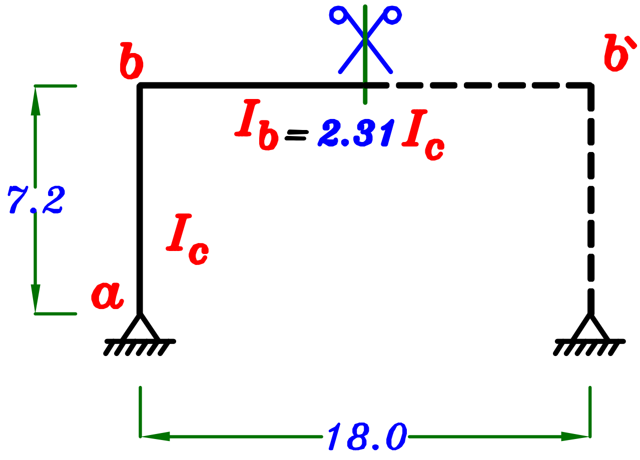
For Joint b

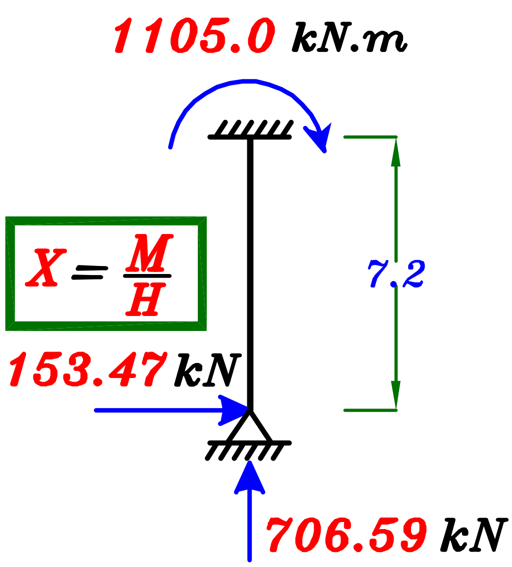
$$K_c = \frac{3}{4}\frac{I_c}{h} = \frac{3}{4} * \frac{I_c}{7.20} = 0.104\, I_c$$

$$K_b = \frac{1}{2}\frac{I_b}{L} = \frac{1}{2} * \frac{(2.31) I_c}{18.0} = 0.0641\, I_c$$

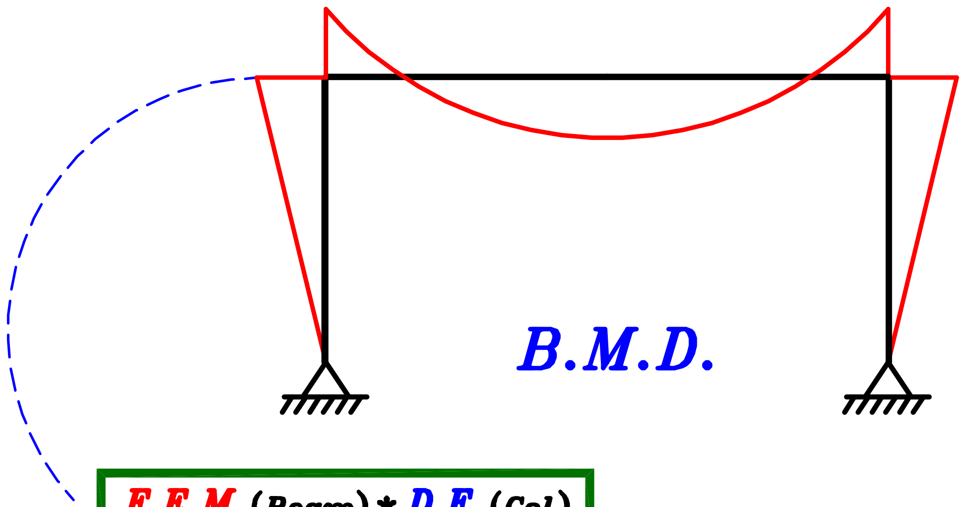
$$D.F._c = \frac{0.104}{0.104 + 0.0641} = 0.6186$$

$$D.F._b = 1 - 0.6186 = 0.3814$$



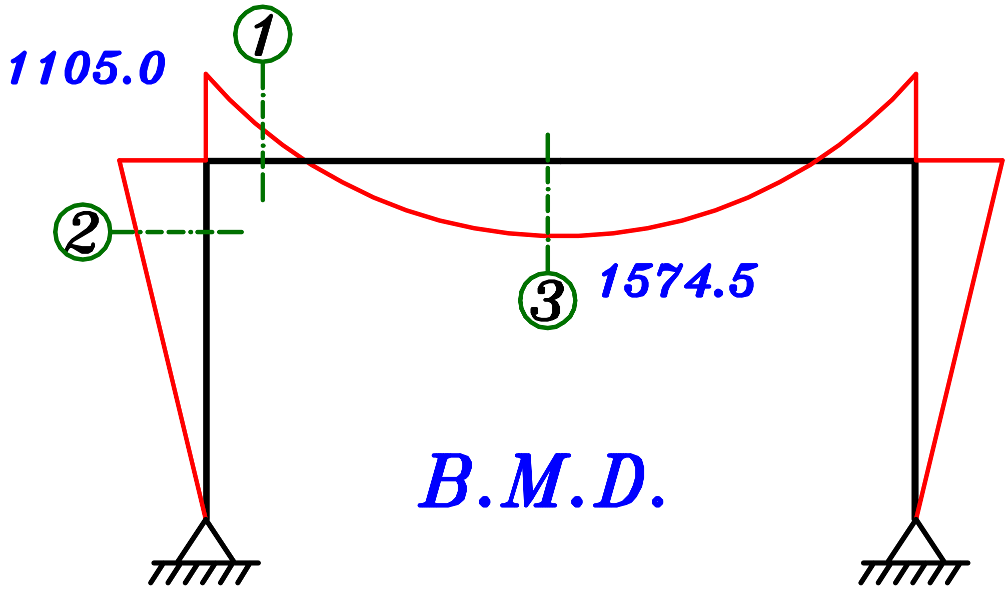


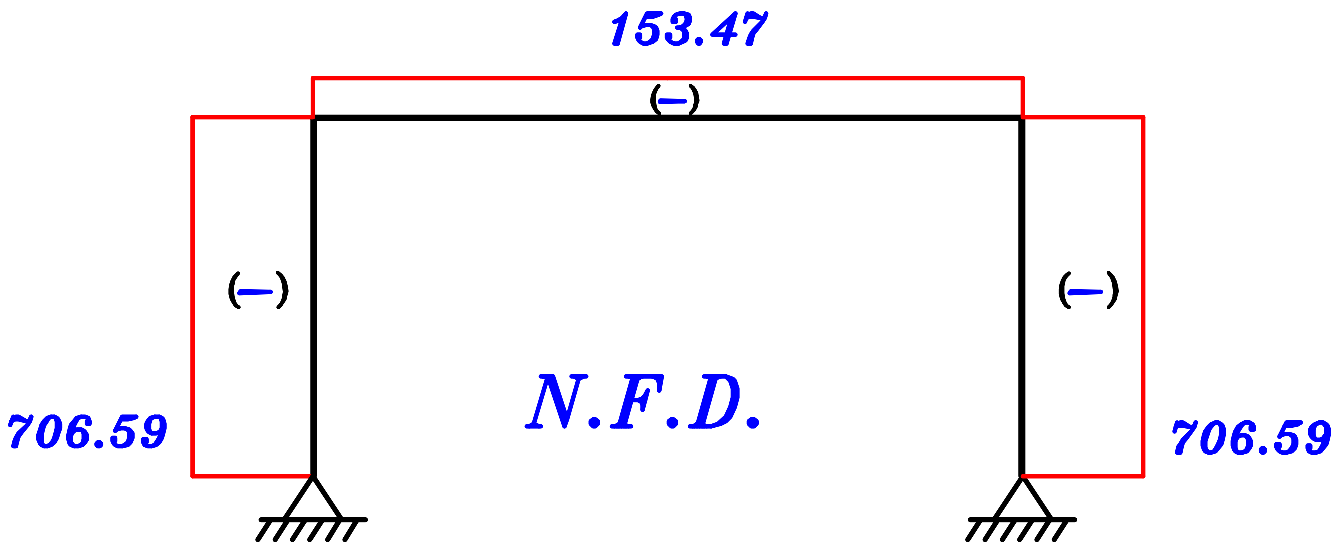
$$\boxed{X = \frac{M}{H}}$$



$$\boxed{F.E.M.(Beam) * D.F.(Col)}$$

$$\boxed{1786.3 * 0.6186 = 1105.0}$$





Design of Sections.

Sec. 1 R−Sec.

$M = 1105.0$ kN.m , $P = 153.47$ kN , $b = 400$ mm , $t = 1400$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{153.47 * 10^3}{25 * 400 * 1400} = 0.0109 < 0.04$ (neglect P)

$$\therefore 1300 = C_1 \sqrt{\frac{1105.0 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.91 \longrightarrow J = 0.80$$

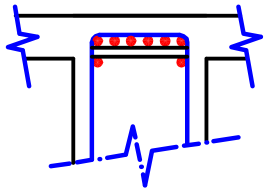
$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1105.0 * 10^6}{0.80 * 360 * 1300} = 2951.4 \text{ mm}^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 2951.4\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b\ d \quad \therefore$ Take $A_s = A_{s_{req.}} = 2951.4\ mm^2$ $\quad$ $8 \phi 22$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{22 + 25} = 7.97 = 7.0 \text{ bars}$$



Sec. ② R−Sec. Neglect Effect of Buckling.

$M = 1105.0$ kN.m , $P = 706.59$ kN

Check $\dfrac{P}{F_{cu}\, b t} = \dfrac{706.59 * 10^3}{25 * 400 * 1400} = 0.0504 > 0.04$ (Don't neglect P)

$e = \dfrac{M}{P} = \dfrac{1105.0}{706.59} = 1.563\ m \qquad \therefore \dfrac{e}{t} = \dfrac{1.563}{1.40} = 1.116 > 0.5 \xrightarrow{use} e_s$

$$e_s = e + \frac{t}{2} - c = 1.563 + \frac{1.4}{2} - 0.1 = 2.163\ m$$

$$M_s = P * e_s = 706.59 * 2.163 = 1528.35\ kN.m$$

$$\therefore 1300 = C_1 \sqrt{\frac{1528.35 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.32 \longrightarrow J = 0.769$$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{1528.35 * 10^6}{0.769 * 360 * 1300} - \frac{706.59 * 10^3}{(360 \backslash 1.15)}$$

$$= 1989.5\ mm^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 1989.5\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b\ d \quad \therefore$ Take $A_s = A_{s_{req.}} = 1989.5\ mm^2$ $\quad$ $6 \phi 22$

Sec. ③ T–Sec.

$M = 1574.5$ kN.m , $P = 153.47$ kN , $b = 400$ mm , $t = 1400$ mm

Check $\dfrac{P}{F_{cu}\,b\,t} = \dfrac{153.47 * 10^3}{25 * 400 * 1400} = 0.011 < 0.04$ (neglect P)

$$B = \begin{cases} C.L. - C.L. = Spacing = 6.5\,m = 6500\,mm \\ 16\,t_s + b = 16 * 120 + 400 = 2320\,mm \\ K\,\dfrac{L}{5} + b = 0.7 * \dfrac{18000}{5} + 400 = 2920\,mm \end{cases} \qquad \boxed{B = 2320\,mm}$$

$$\therefore 1300 = C_1 \sqrt{\frac{1574.5 * 10^6}{25 * 2320}} \longrightarrow C_1 = 7.89 \longrightarrow J = 0.826$$

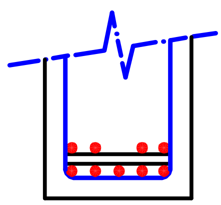
$$\therefore A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{1574.5 * 10^6}{0.826 * 360 * 1300} = 4073.0\ mm^2$$

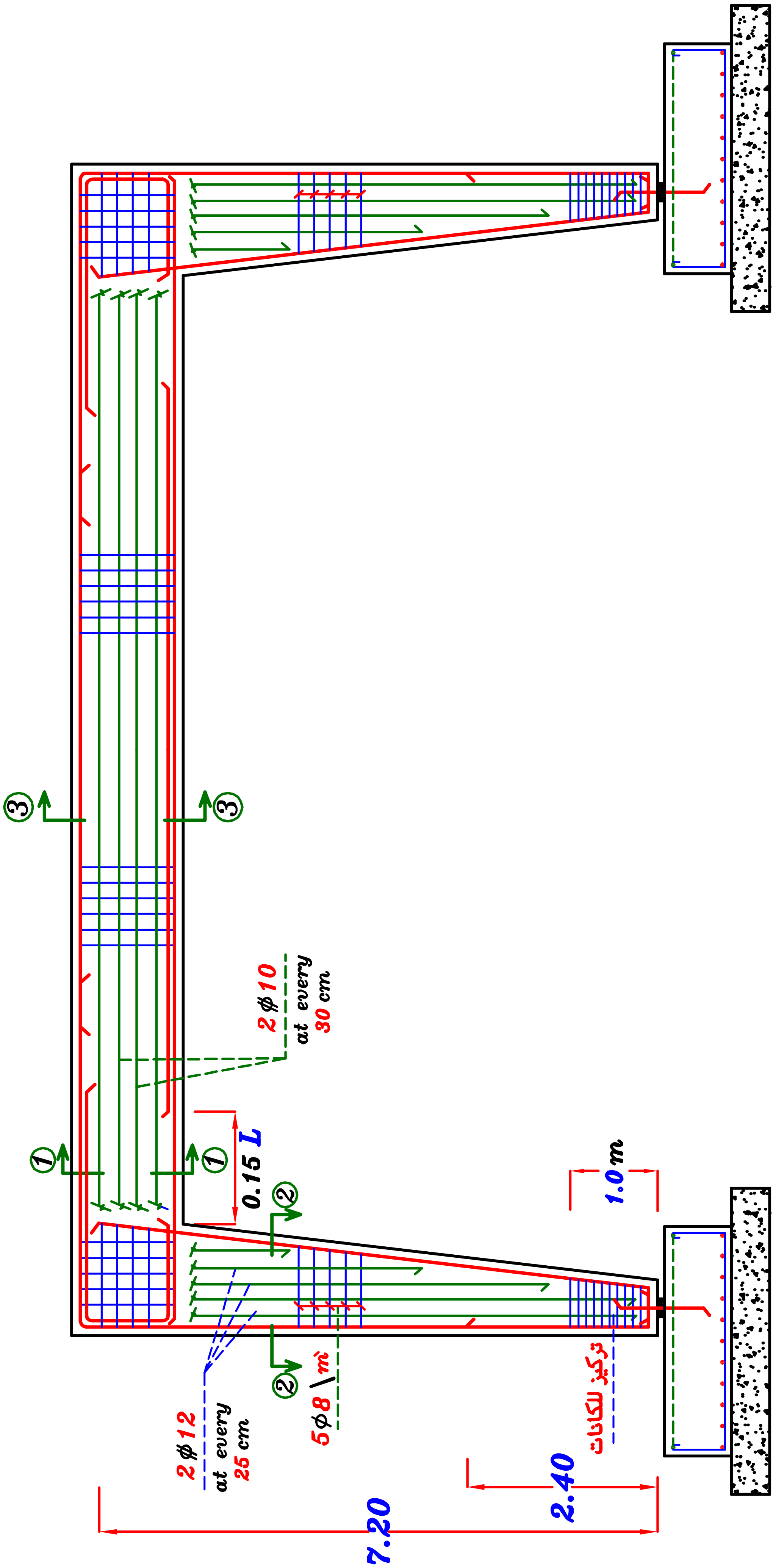
Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 4073.0\ mm^2$

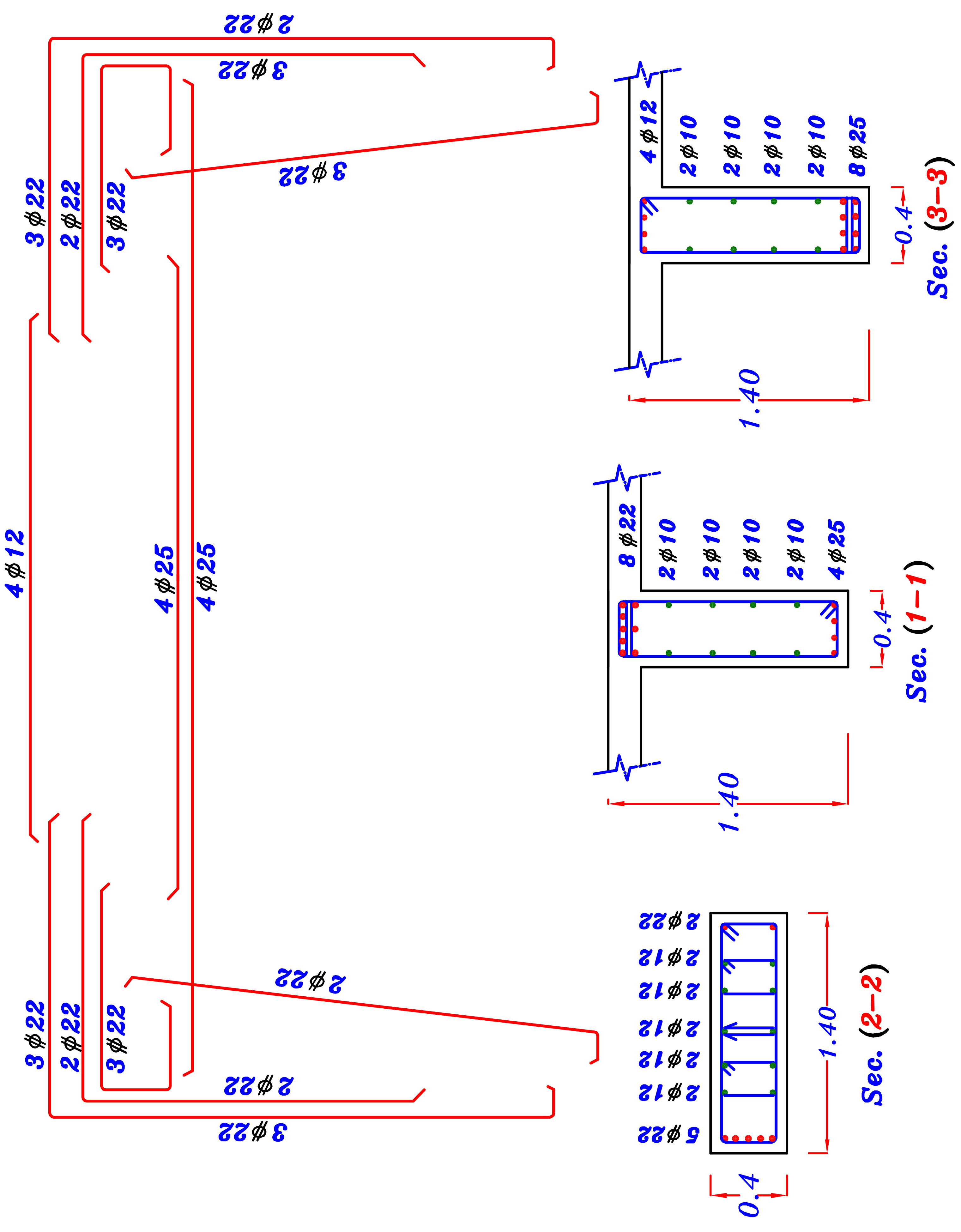
$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\,b\,d \quad \therefore$ Take $A_s = A_{s_{req.}} = 4073.0\ mm^2$ $\quad$ 9ϕ25

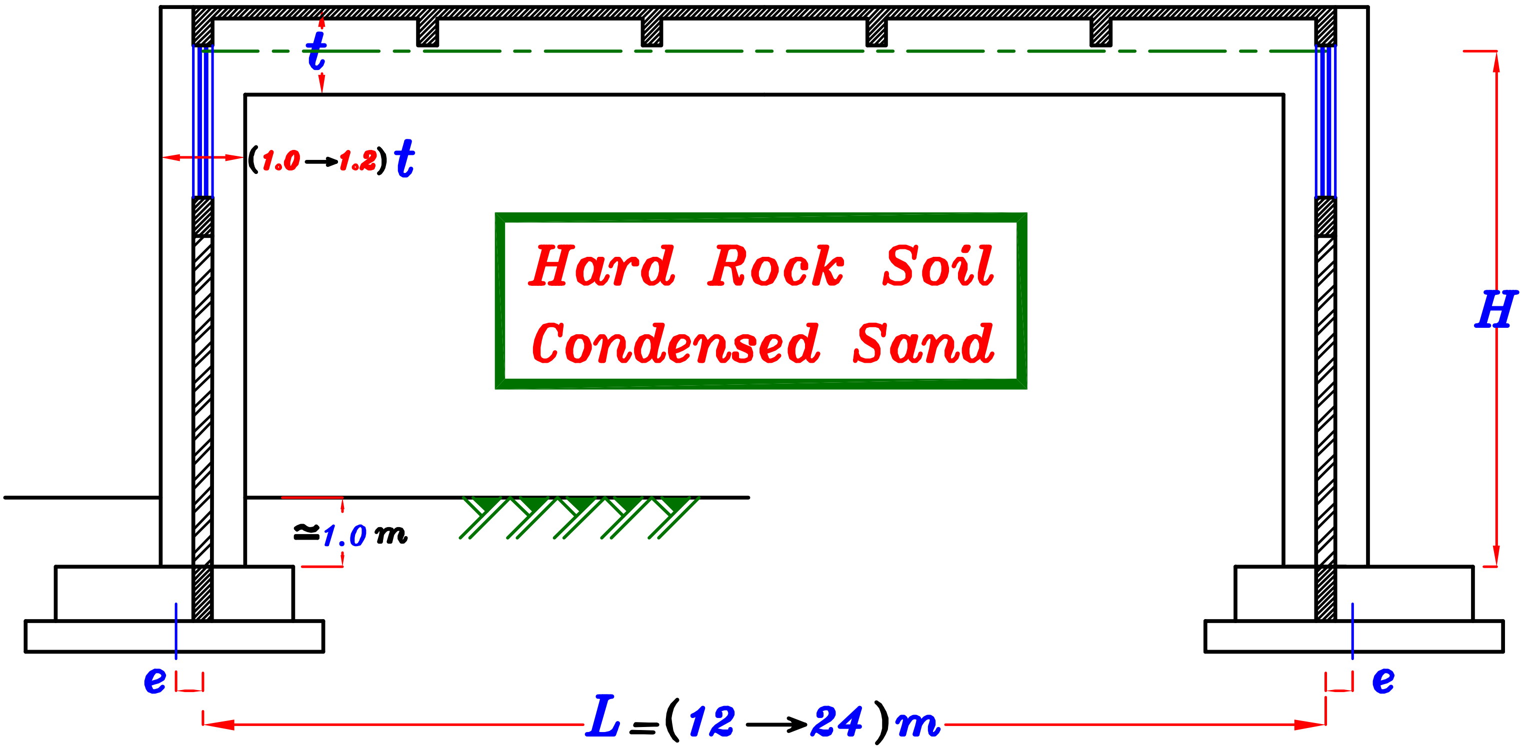
$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{25 + 25} = 7.50 = 7.0 \text{ bars}$$




2 ϕ 10
at every
30 cm
0.15 L
1.0 m
2 ϕ 12
at every
25 cm
5 ϕ 8 \ m'
تركيز للكانات
2.40
7.20
1
2
3


Sec. (1-1)
Sec. (2-2)
Sec. (3-3)
4 ϕ 12
4 ϕ 25
4 ϕ 25
3 ϕ 22
2 ϕ 22
3 ϕ 22
1.40
0.4

Fixed Straight Frame.



– Statical System

The Fixed Frame is Two Times Statically indet.

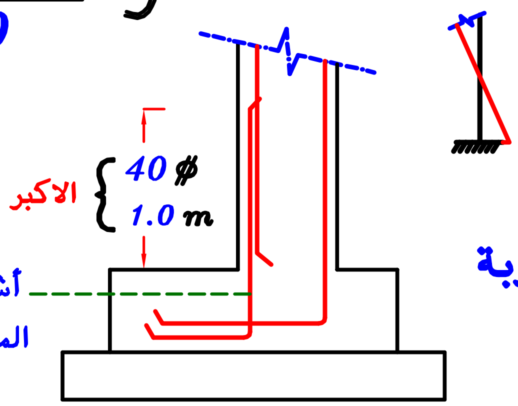
لانه symmetric

– Concrete Dimensions.

* Span (L) = (12 → 24) m

* $t \simeq \dfrac{L}{14 \rightarrow 16}$

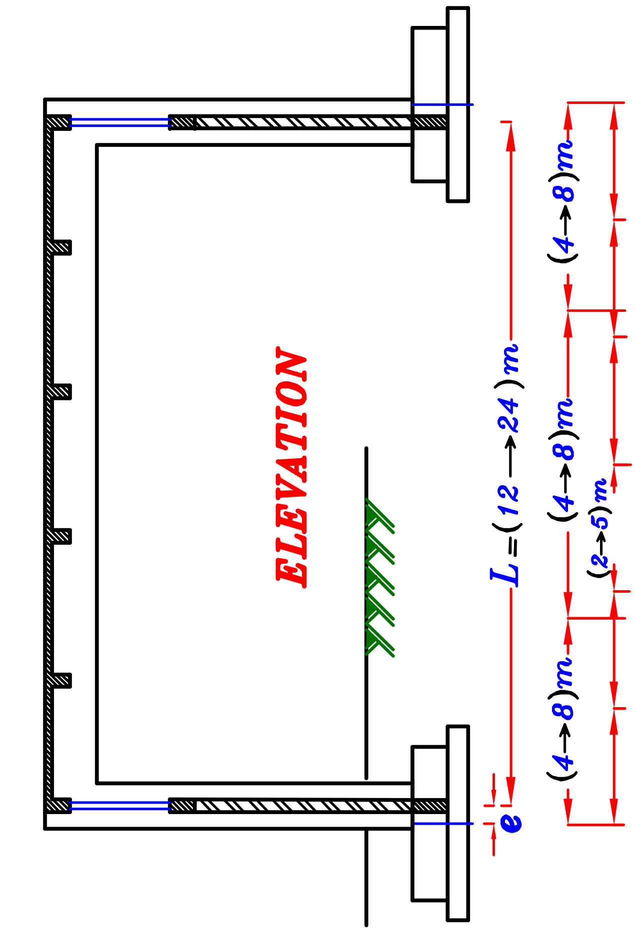
* $b = \left.\begin{array}{l} 0.30\ m \\ \dfrac{Spacing}{20} \end{array}\right\}$ الأكبر

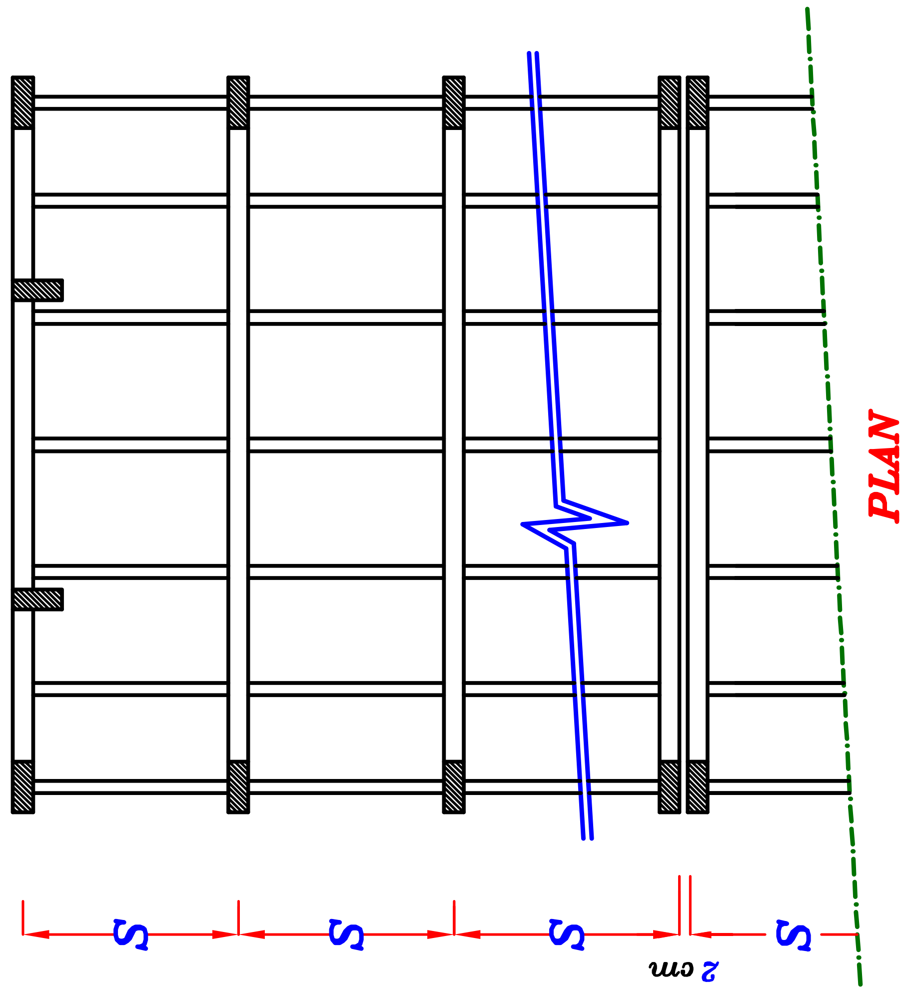


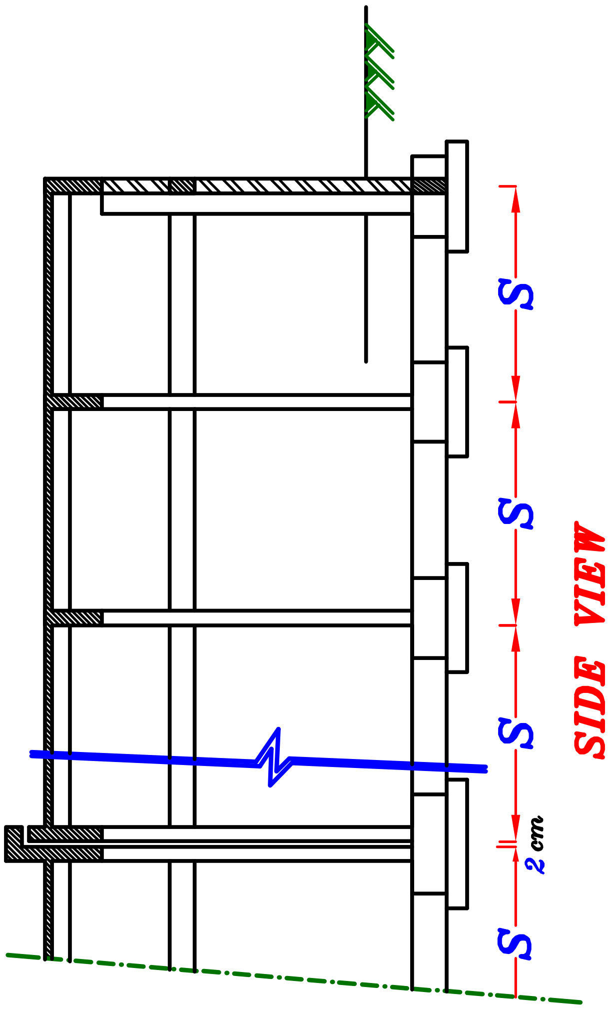
(M) ترحل القواعد عكس إتجاه ال

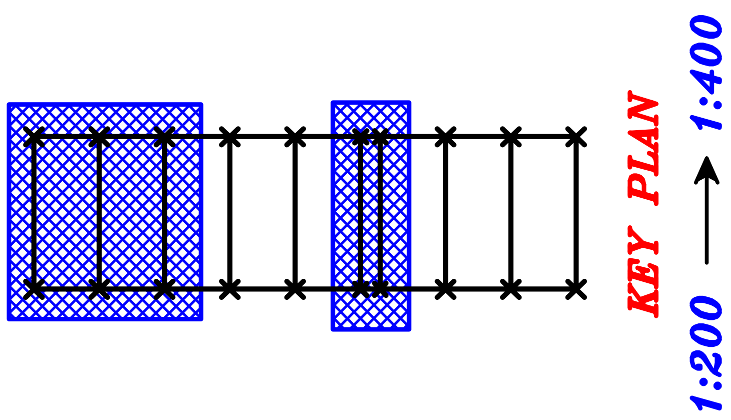
(e) ترحل القواعد للخارج مسافة

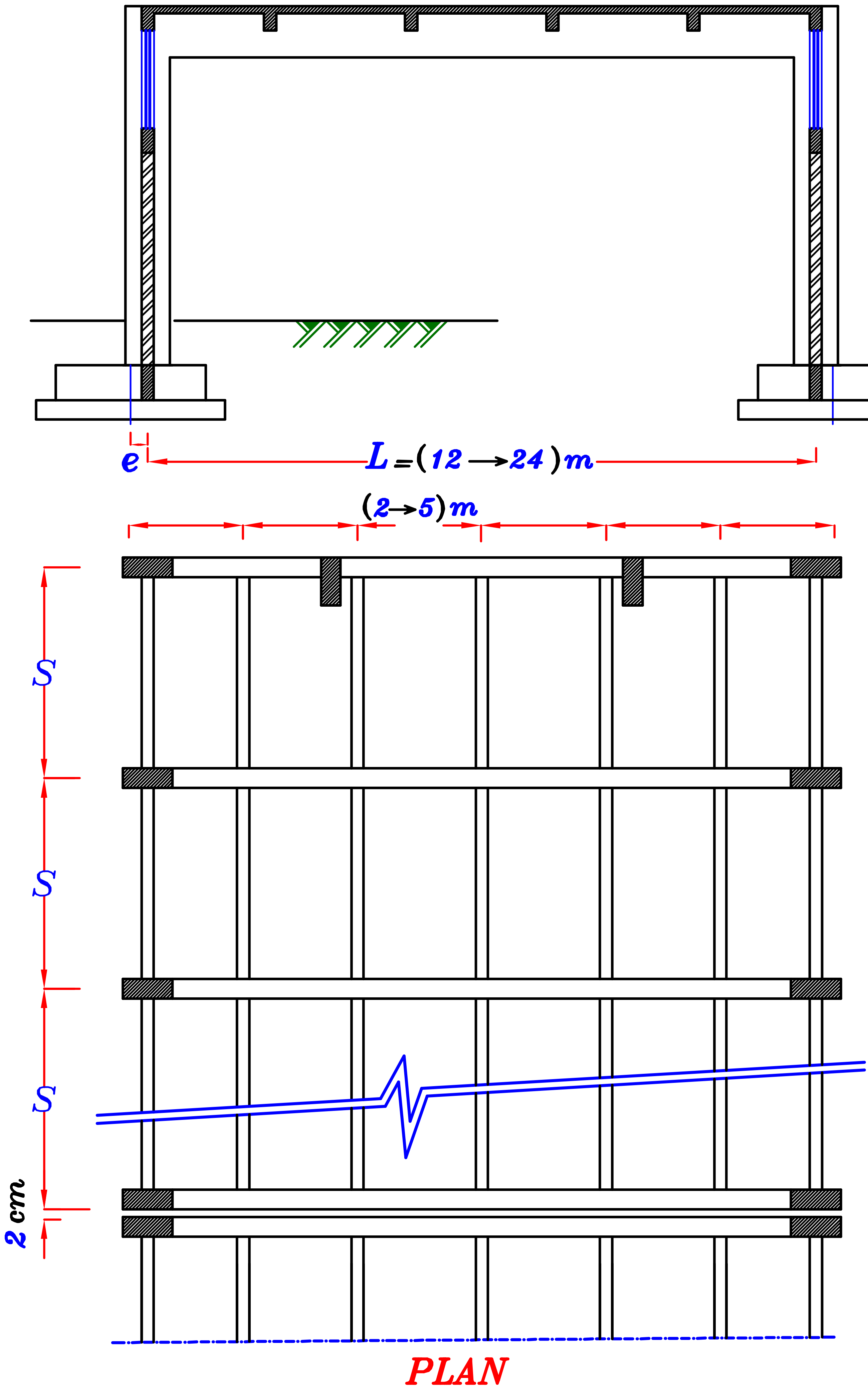
لعمل uniform stress على التربة


ELEVATION
L=(12 → 24) m
(4→8)m
(4→8)m
(4→8)m
(2→5)m
e


PLAN
S
S
S
S
2 cm


SIDE VIEW
S
S
S
S
2 cm


KEY PLAN
1:200 → 1:400


e
L =(12 ⟶ 24)m
(2⟶5)m
S
S
S
2 cm
PLAN

Steps of Design.

خطوات المسأله .

١- اختيار ال *system*
٢- رسم *concrete Dim.* فى ال *Plan & elevation*
٣- رسم تسليح البلاطه على نفس ال *Plan*
٤- عمل *Load distribution* للبلاطات و حساب الاحمال على ال *System*
٥ - حل ال *System* و رسم *B.M.D. & N.F.D.*
٦- تصميم قطاعات ال *System* على *M,N*
٧- رسم تسليح ال *System* فى ال *cross-sec. & elevation*

Moment Distribution Method.

ⓐ *Get Moment of Inertia For all members.* « I »

ⓑ *Get Distribution Factors at all Joints.* « *D.F.* »

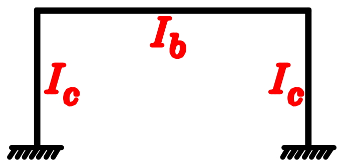
ⓒ *Get Fixed End Moments For Beams.* « *F.E.M.* »

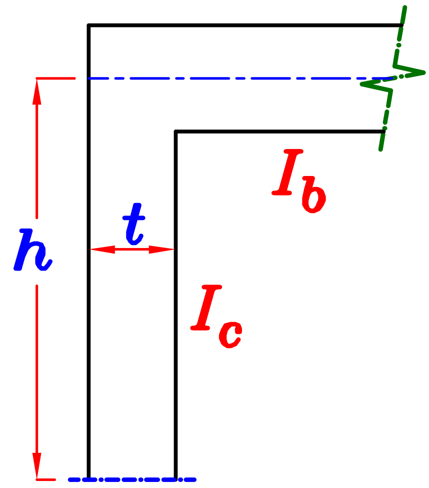
ⓓ *Get the Final Moment.* « M_F »

ⓔ *Get B.M.D. , N.F.D. , N.F.D.*

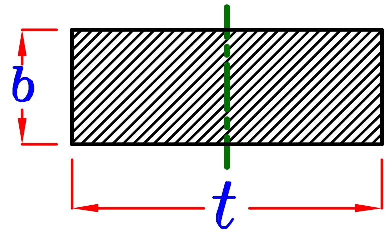
1- Calculate Moment of Inertia For members.

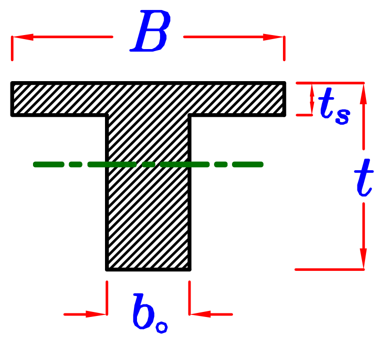
* **For Column.**





$$I_c = \frac{b\,(t)^3}{12}$$





* **For Beams.**

$$I_b = (\mu * 10^{-4})\; B\, t^3$$

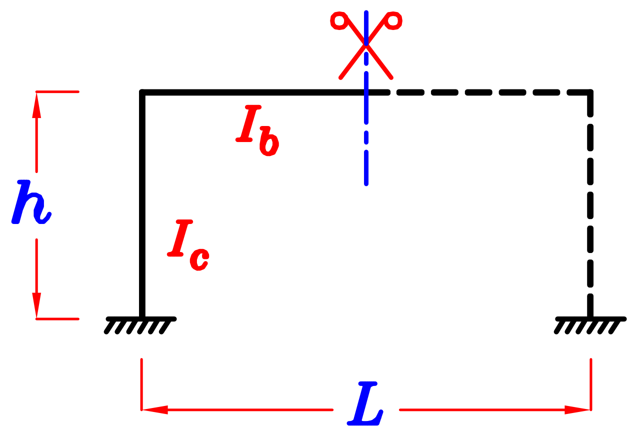
2- Get the Distribution Factor.

$$K_b = \frac{1}{2}\,\frac{I_b}{L}$$

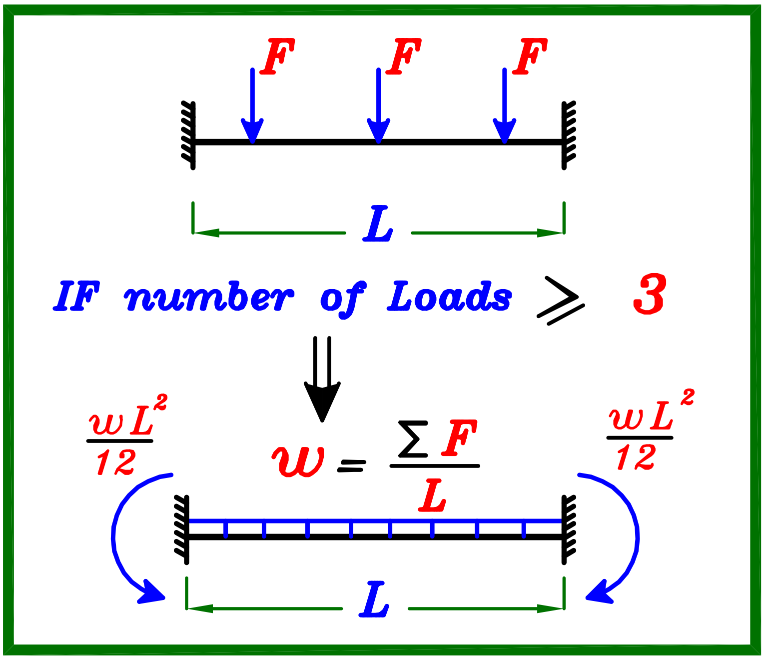
$$K_c = \frac{I_c}{h}$$

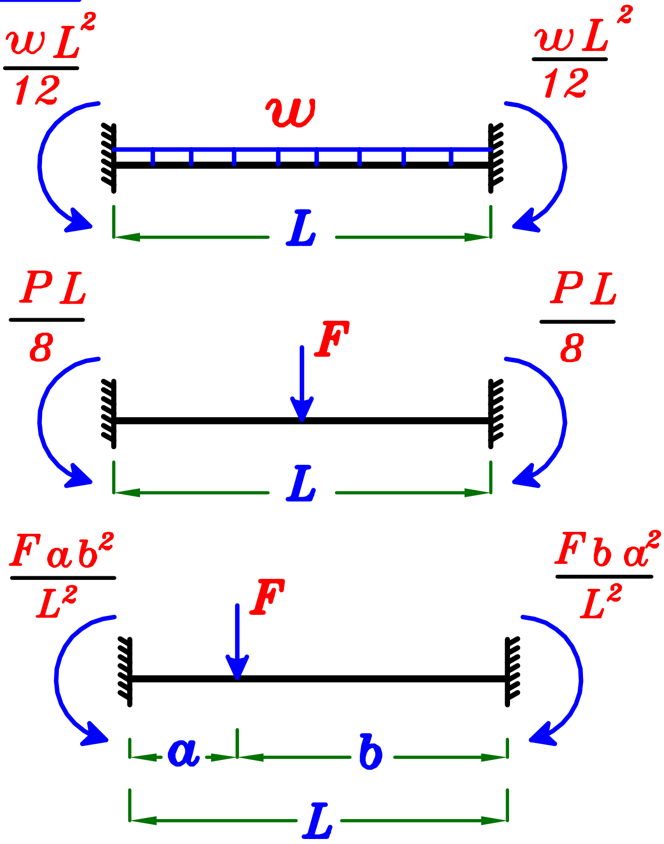
$$D.F._c = \frac{K_c}{K_b + K_c}$$

$$D.F._b = \frac{K_b}{K_b + K_c}$$



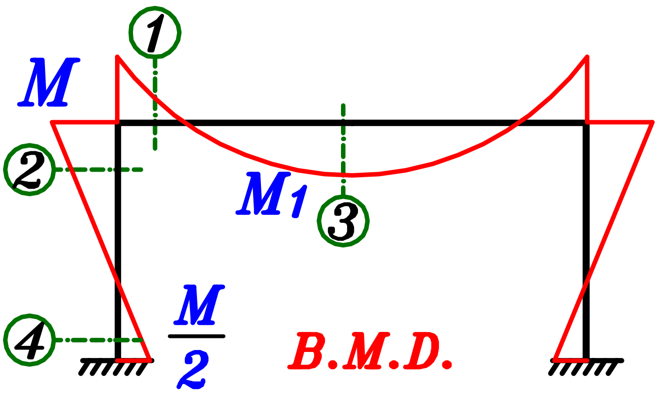
3- Get Fixed End Moment.

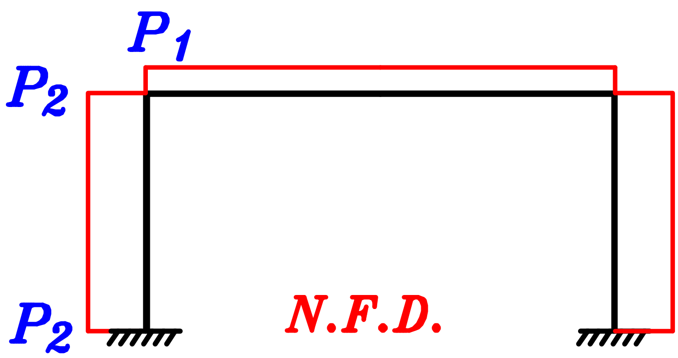


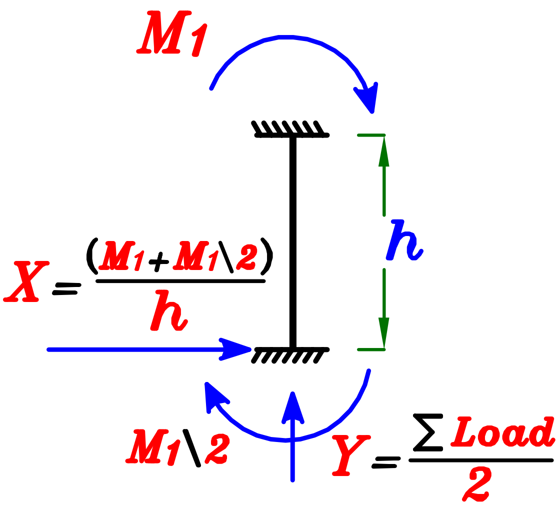


4- Calculate the moment.

$$\boxed{M = F.E.M.\,(Beam) * D.F.\,(Col.)}$$







Design:

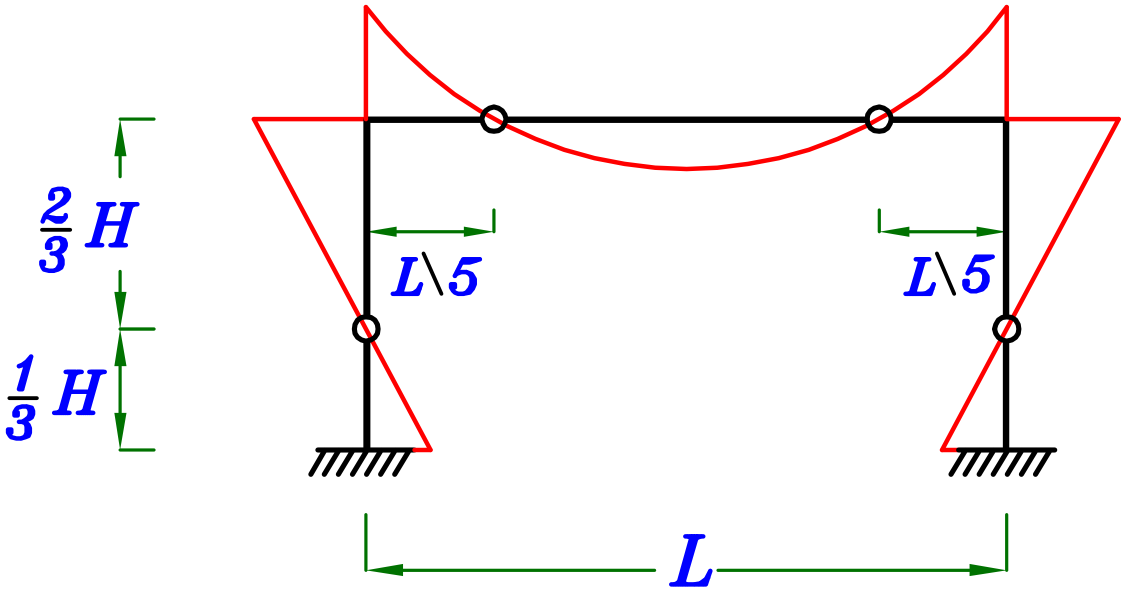
Sec. ① on M , P_1 R- Sec.

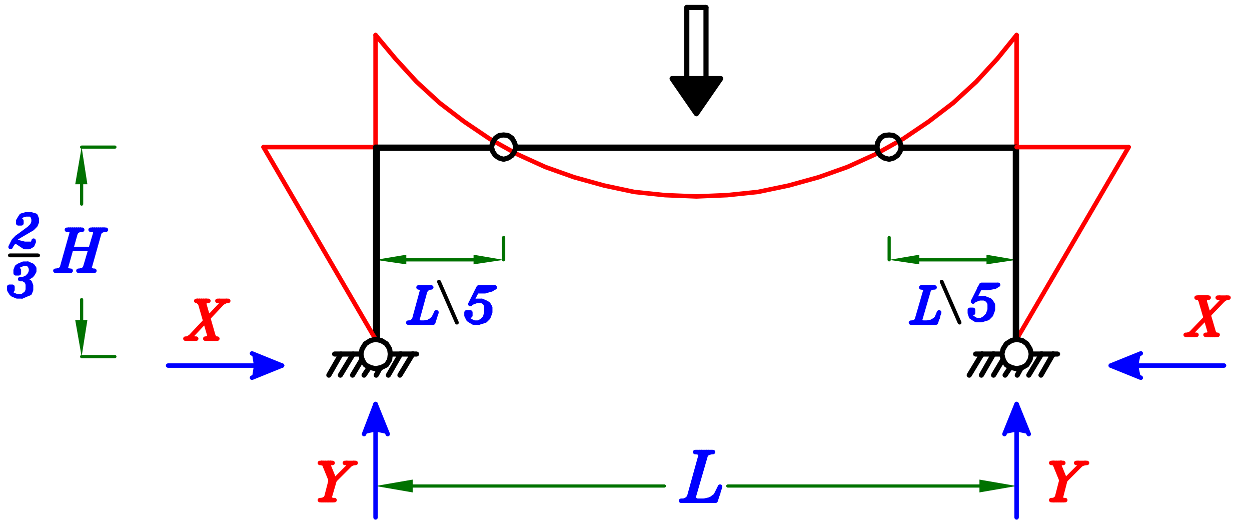
Sec. ② on M , P_2 R- Sec.

Sec. ③ on M_1 , P_1 T- Sec.

Sec. ④ on $\frac{M}{2}$, P_2 R- Sec.

Approximate Solution.





assume that in the column there is an intermediate hinge at $\frac{H}{3}$

so we can solve the Frame as Two hinged Frame but with height $\frac{2}{3}H$

assume that in the beam there is an intermediate hinge at $\frac{L}{5}$

$$Y = \frac{\sum Loads}{2}$$

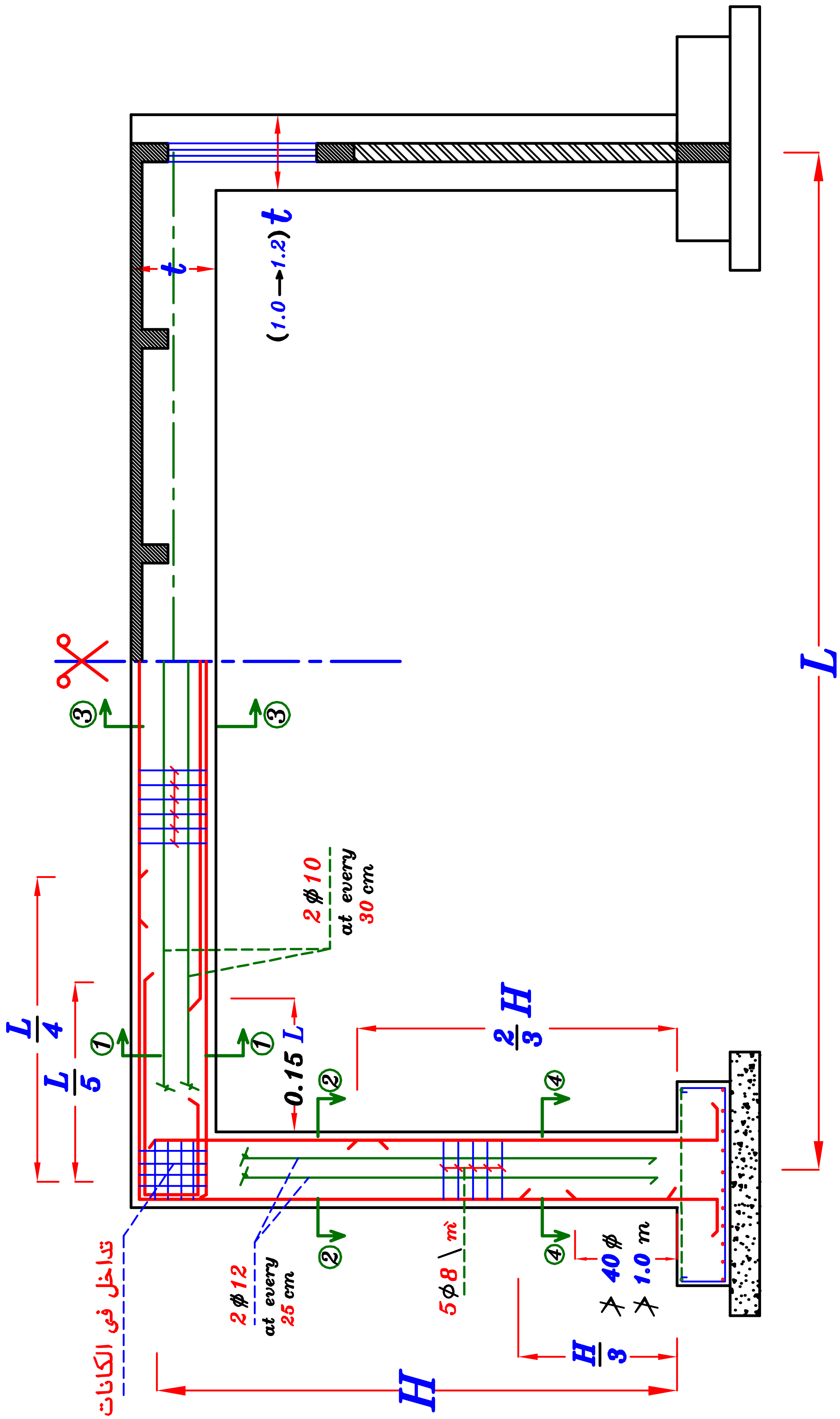
To get the reactions X

Take the moment at Point a = Zero

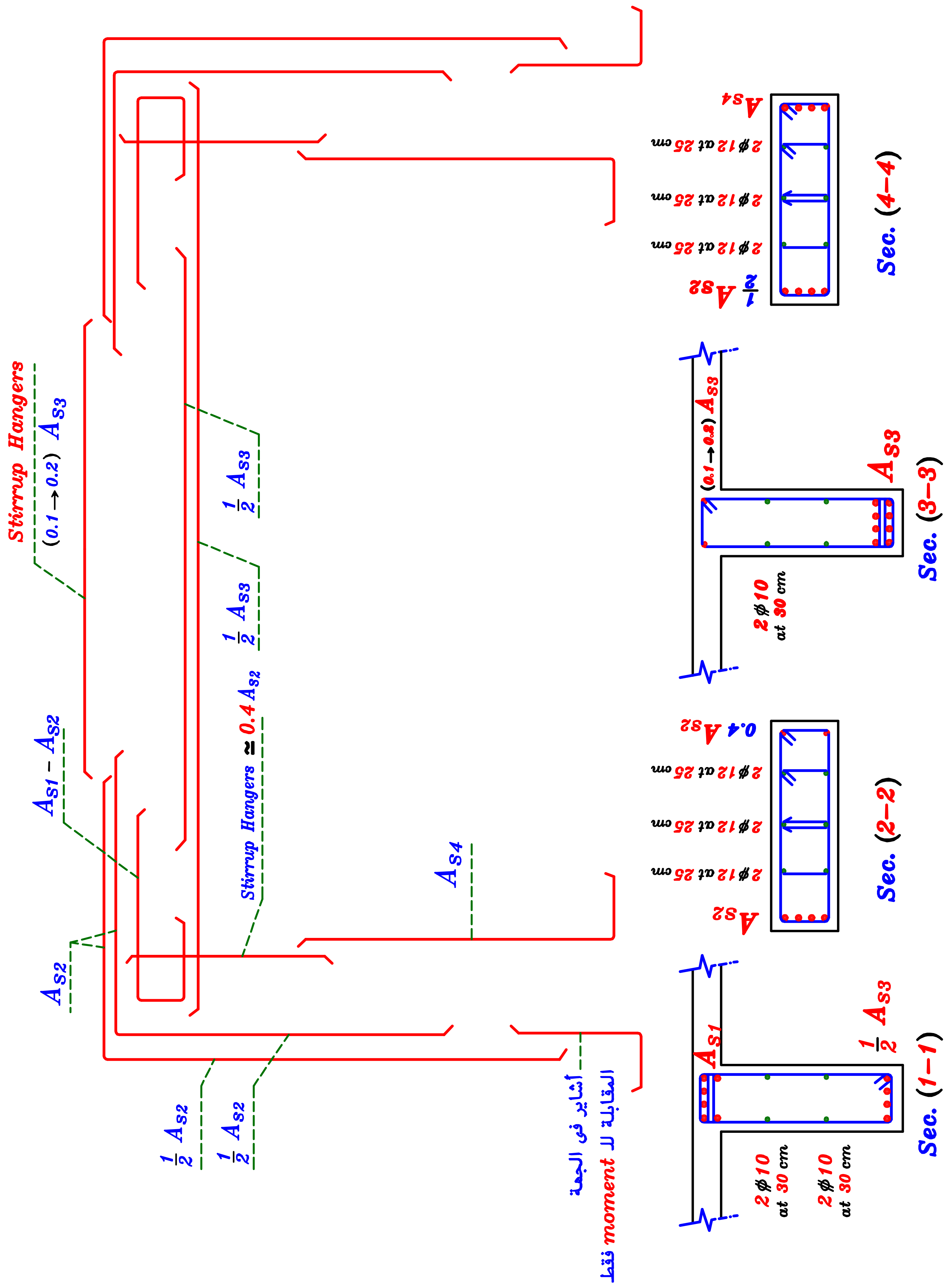
Then Draw Internal Forces Diagrams.

ملحوظه هامه

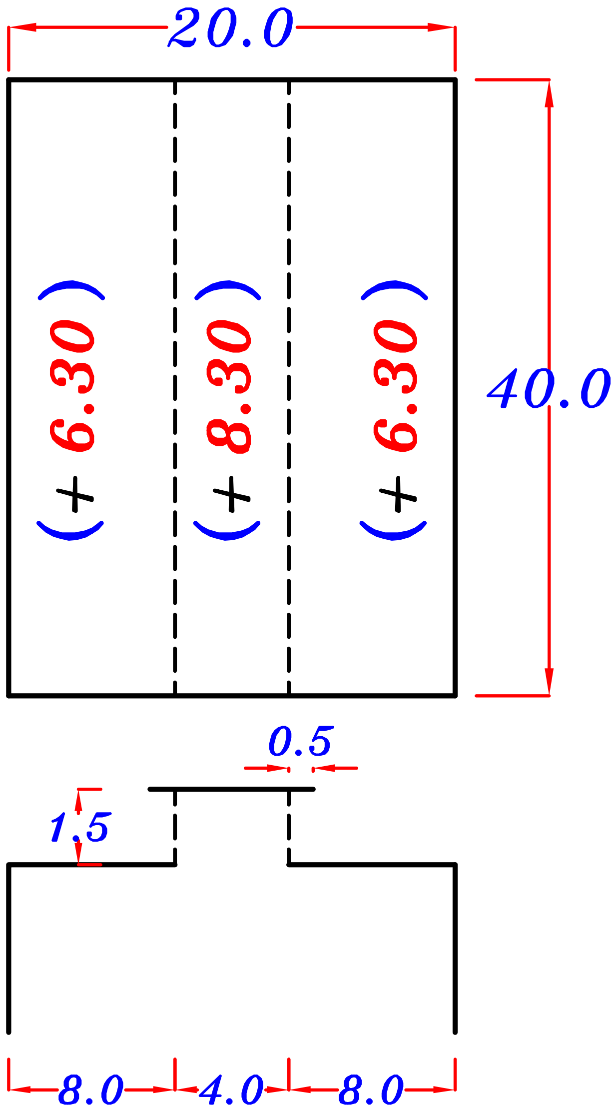
هذا الحل حل تقريبى جدا و غير دقيق ، لذا لن نستخدم هذا الحل
الا مع تعذر الوقت فى الامتحان



t
(1.0 → 1.2) t
L
L/4
L/5
0.15 L
2φ10
at every
30 cm
2H/3
2φ12
at every
25 cm
5φ8 \ m'
40φ
1.0 m
H/3
H
تداخل فى الكانات


Stirrup Hangers
(0.1 → 0.2) As3
As1 - As2
As2
1/2 As2
1/2 As2
1/2 As3
1/2 As3
Stirrup Hangers ≃ 0.4 As2
As4
أشاير فى الجهة
المقابلة للـ moment فقط
Sec. (1-1)
As1
1/2 As3
2 φ 10 at 30 cm
2 φ 10 at 30 cm
Sec. (2-2)
As2
0.4 As2
2 φ 12 at 25 cm
2 φ 12 at 25 cm
2 φ 12 at 25 cm
Sec. (3-3)
As3
(0.1 → 0.2) As3
2 φ 10 at 30 cm
Sec. (4-4)
As4
1/2 As2
2 φ 12 at 25 cm
2 φ 12 at 25 cm
2 φ 12 at 25 cm

Example.



$F_{cu.} = 25$ N\mm^2 $\quad F_y = 360$ N\mm^2

L.L. $= 2.0$ kN\m^2 $\quad$ F.C. $= 1.50$ kN\m^2

Foundation Level. $= -2.0$ m

Window height $= 1.50$ m

Hard soil.

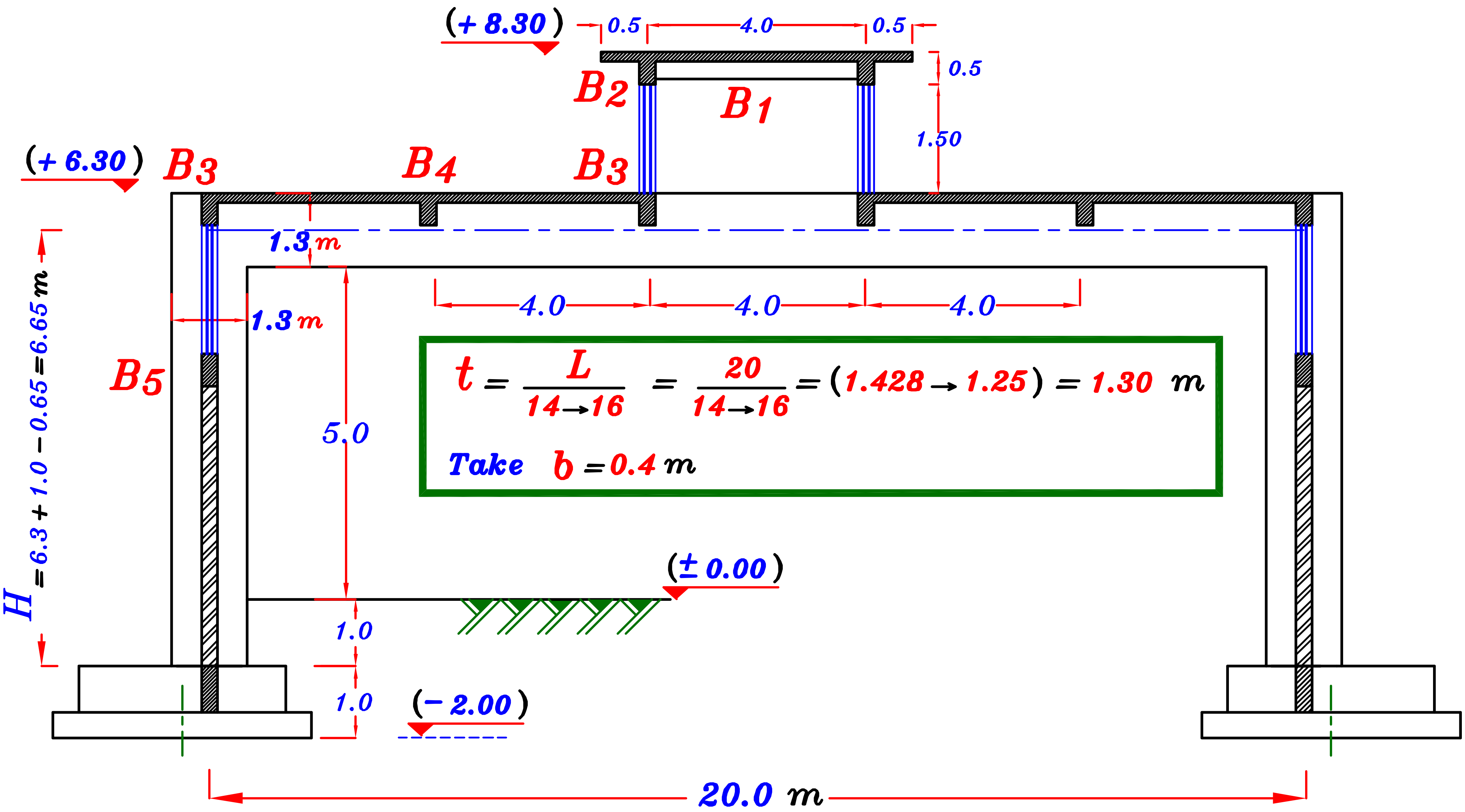
Spacing $= 5.0$ m

Req.

1- Choose a suitable system to cover this area & draw concrete dimensions in elevation For the main supporting element.

2- Design all slabs & draw its details of RFT. in plan.

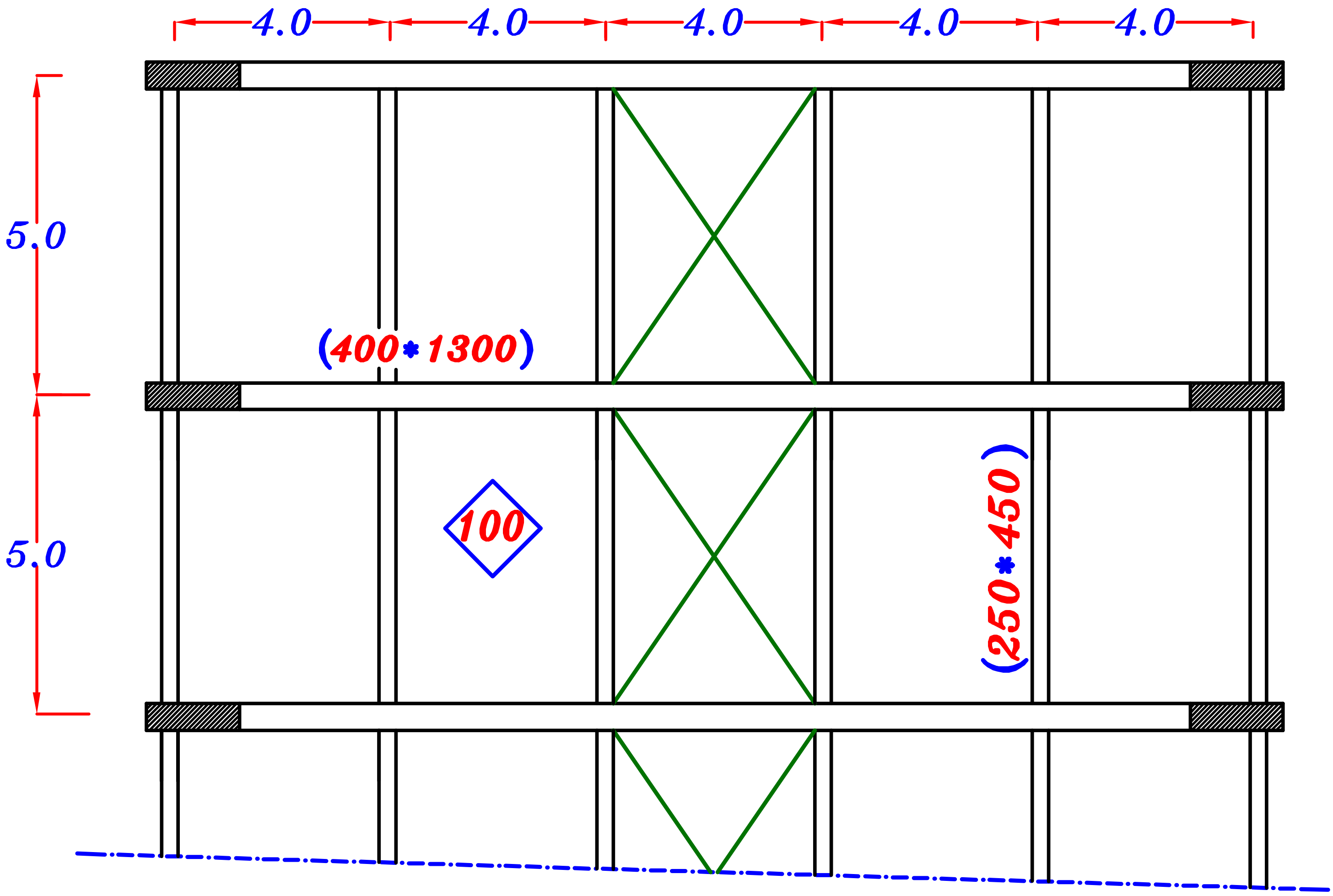
3- Design the main supporting element & draw its details of RFT.



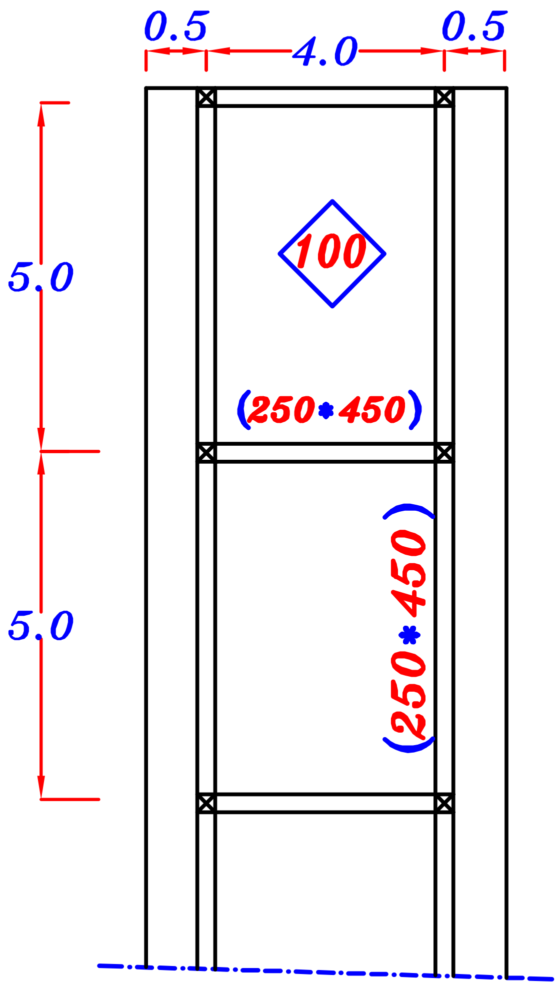
$$t = \frac{L}{14 \rightarrow 16} = \frac{20}{14 \rightarrow 16} = (1.428 \rightarrow 1.25) = 1.30 \ m$$

Take $b = 0.4 \ m$

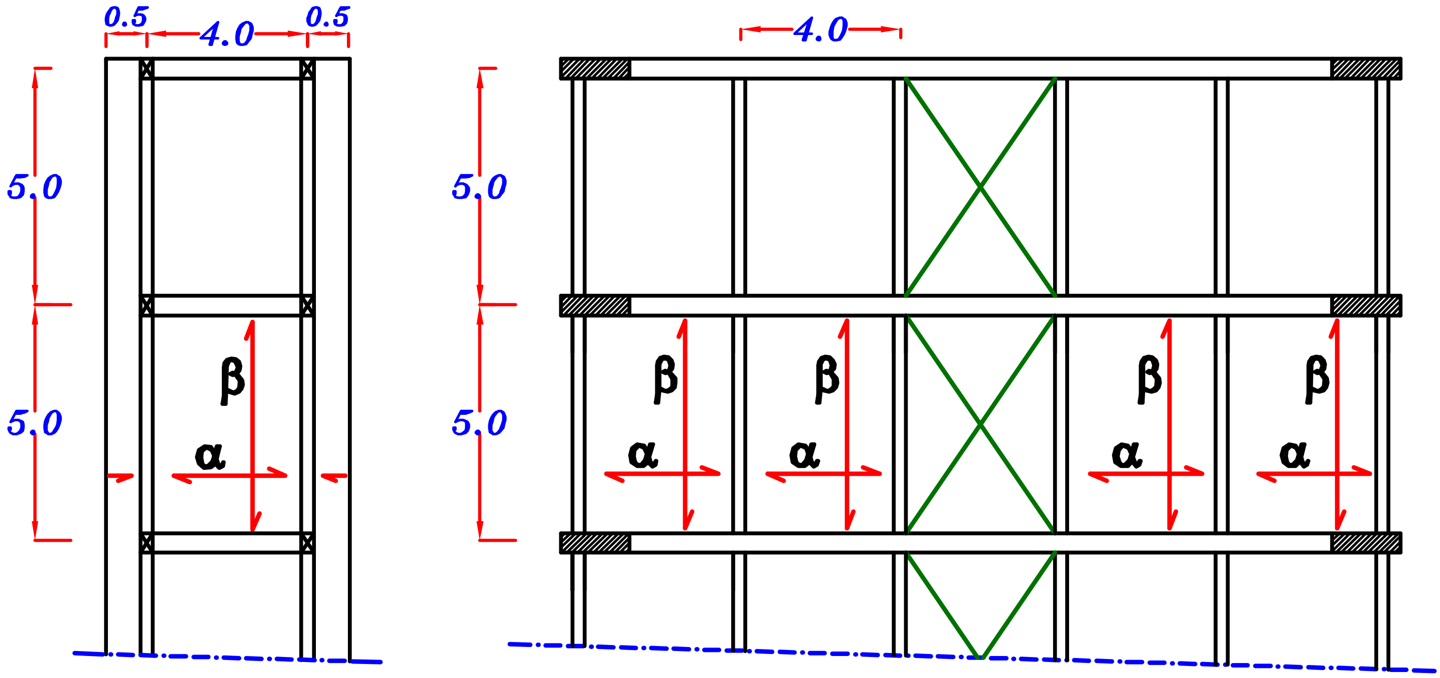
ELEVATION


4.0
4.0
4.0
4.0
4.0
5.0
5.0
(400*1300)
100
(250*450)

PLAN ①


0.5
4.0
0.5
5.0
5.0
100
(250*450)
(250*450)

PLAN ②



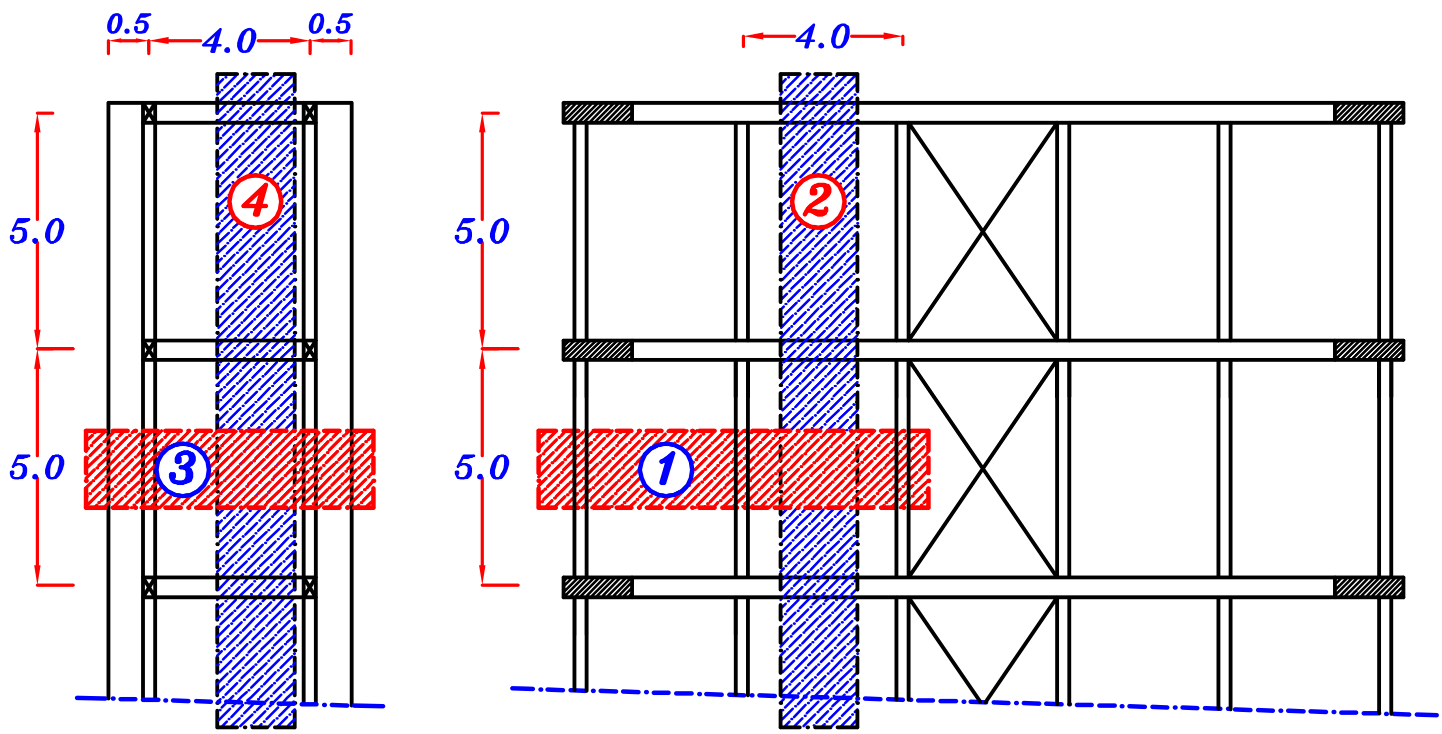
$t_s = \frac{4000}{40} = 100\ mm$ **Take** $\boxed{t_s = 100\ mm}$

$w_s = 1.4\,(0.10 * 25 + 1.50) + 1.6\,(2.0) = 8.80\ kN\backslash m^2$

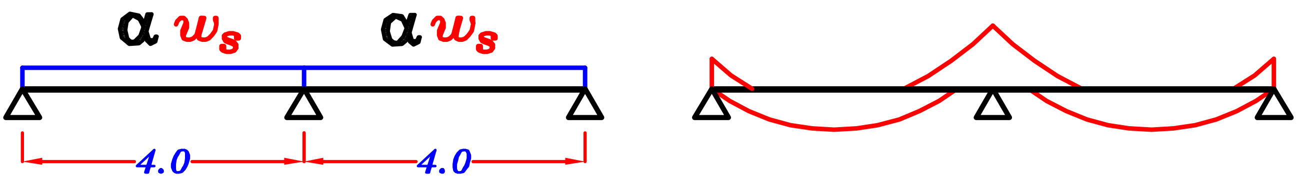
Take $m = 0.76$, $\grave{m} = 0.87$ $r = \frac{m\ L}{\grave{m}\ L_s} = \frac{0.76 * 5.0}{0.87 * 4.0} = 1.09$

$\alpha = 0.5\,r - 0.15 = 0.5\,(1.09) - 0.15 = 0.395$

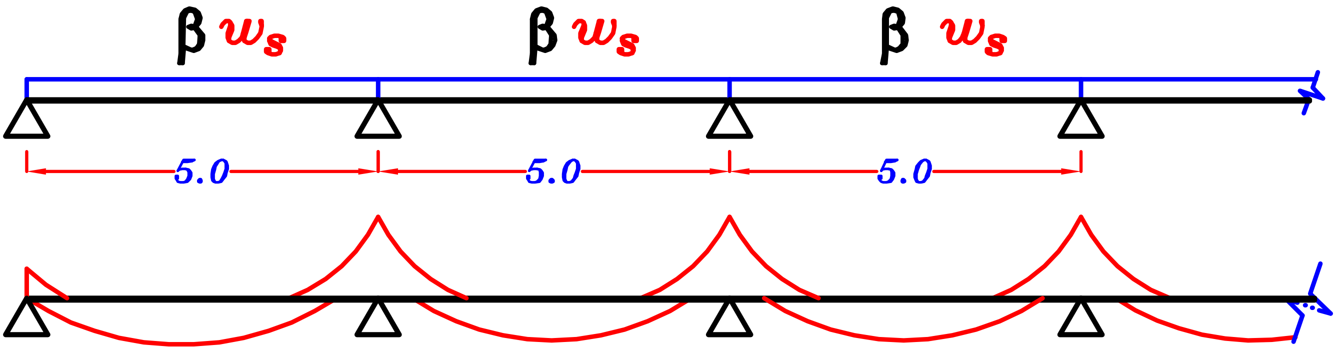
$\beta = \frac{0.35}{r^2} = \frac{0.35}{(1.09)^2} = 0.295$



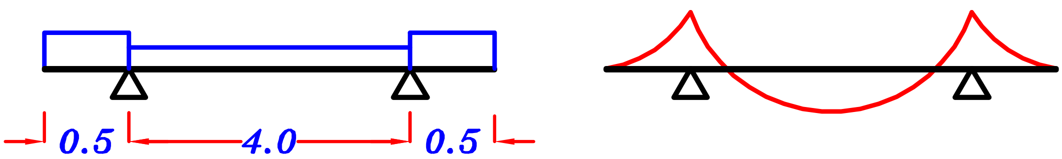
Strip ①

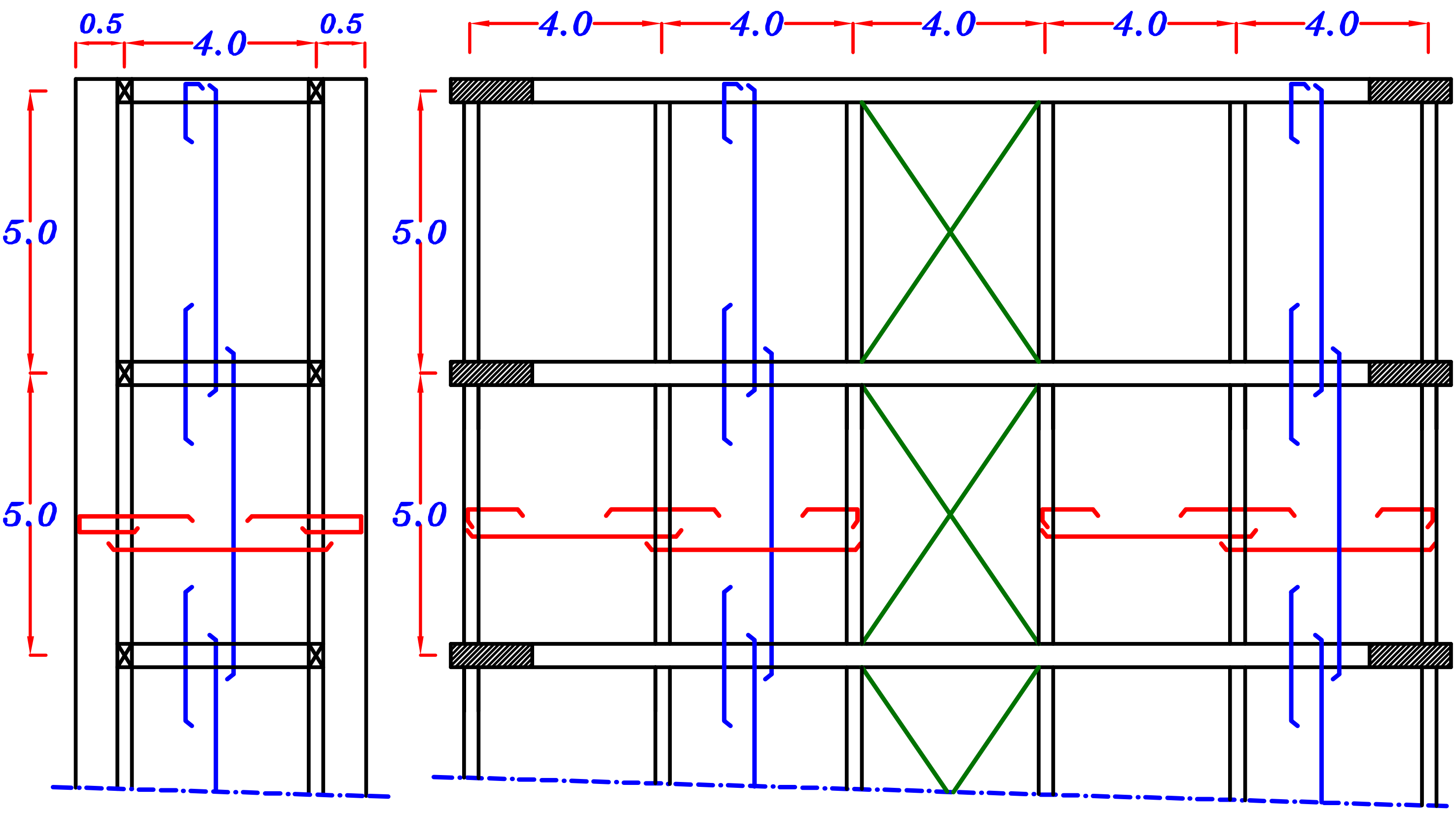


Strip ② & Strip ④

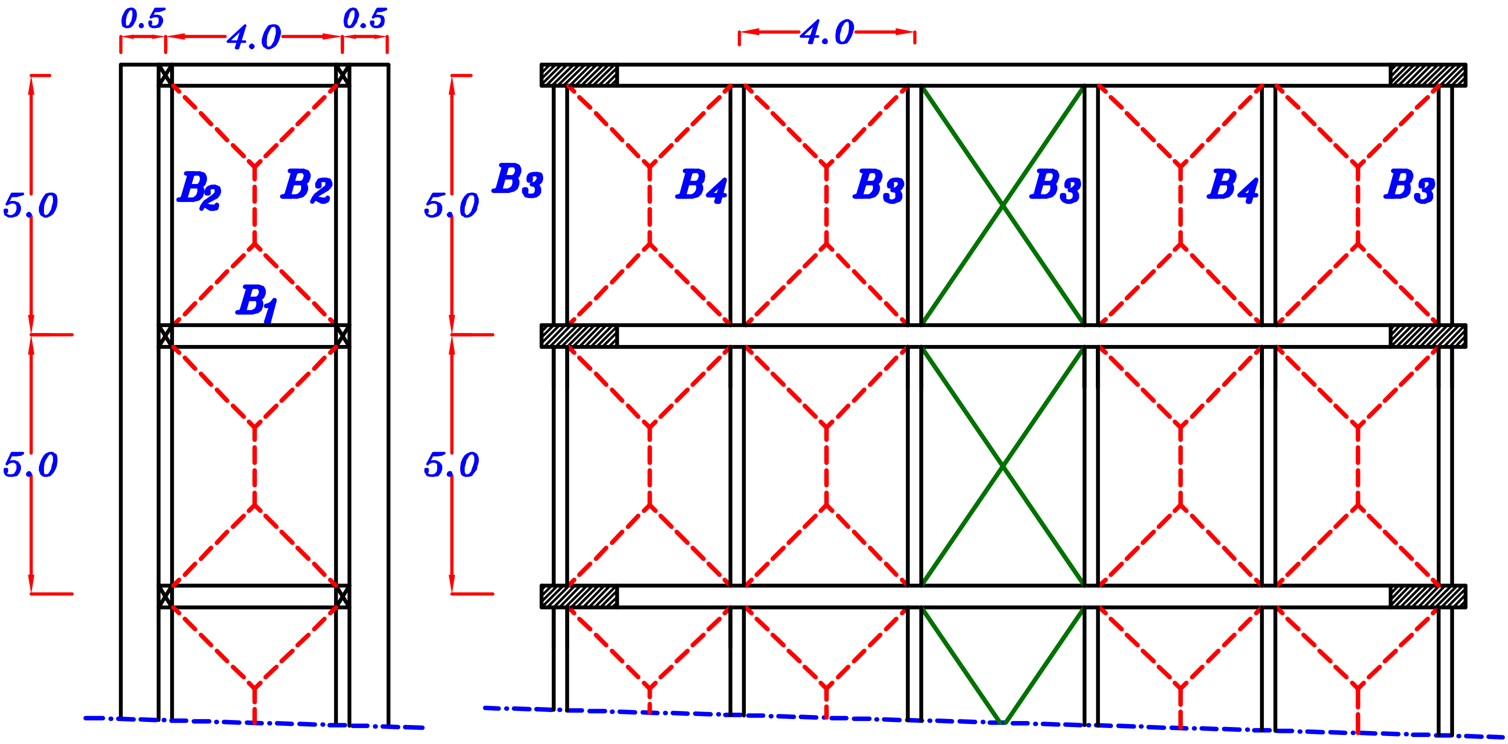


Strip ③





Load Distribution on Beams.



Loads on Beams.

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{5.0}\right) = 0.60$

B1

$w_a = o.w. + 2\, C_a\, w_s\, \frac{L_s}{2} = 4.20 + 2\,(0.50)\,(8.80)\left(\frac{4.0}{2}\right) = 21.8\ kN\backslash m`$

$R_1 = 21.8 * \frac{4.0}{2} = 43.6\ kN$ $\boxed{R_1 = 43.6\ kN}$

B2

$w_a = o.w. + C_a\, w_s\, \frac{L_s}{2} + w_s\, L_c = 4.20 + (0.60)\,(8.80)\left(\frac{4.0}{2}\right) + (8.80)(0.5) = 19.16\ kN\backslash m`$

$R_2 = 19.16 * 5.0 = 95.8\ kN$ $\boxed{R_2 = 95.8\ kN}$

B3

$w_a = o.w. + C_a\, w_s\, \frac{L_s}{2} = 4.20 + (0.60)\,(8.80)\left(\frac{4.0}{2}\right) = 14.76\ kN\backslash m`$

$R_3 = 14.76 * 5.0 = 73.8\ kN$ $\boxed{R_3 = 73.8\ kN}$

B4

$w_a = o.w. + 2\, C_a\, w_s\, \frac{L_s}{2} = 4.20 + 2\,(0.60)\,(8.80)\left(\frac{4.0}{2}\right) = 25.32\ kN\backslash m`$

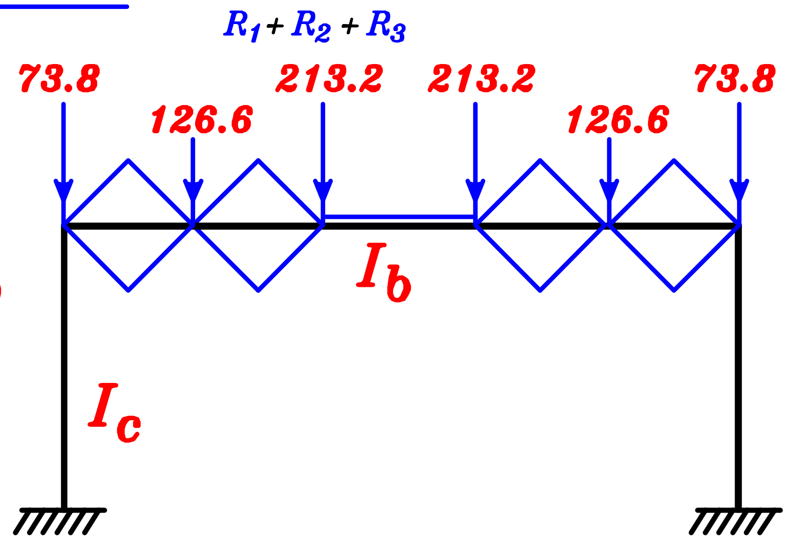
$R_4 = 25.32 * 5.0 = 126.6\ kN$ $\boxed{R_4 = 126.6\ kN}$

B5

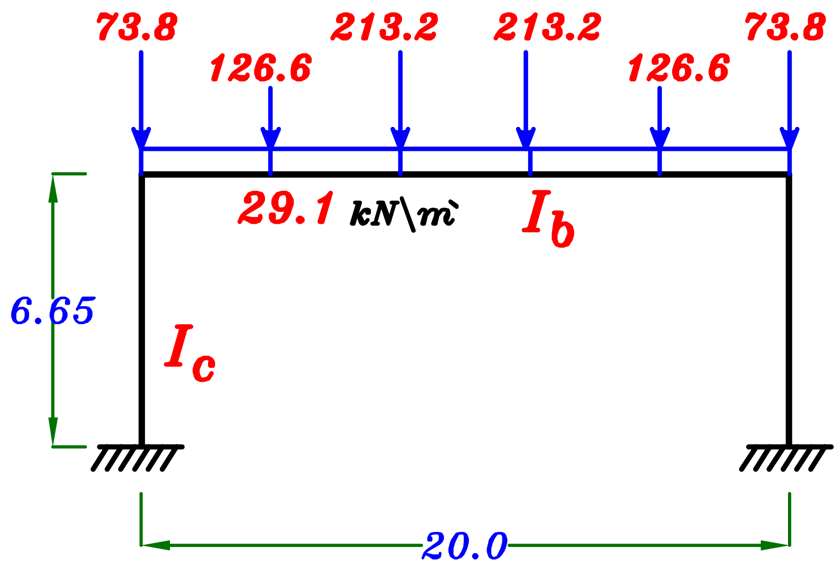
Can be neglected.

Loads on Frame.

Take o.w.(U.L.) = 15.0 kN\m`



$$\frac{\sum area}{span} = \frac{8\left[\left(\frac{1}{2}\right)(4.0)\left(\frac{4.0}{2}\right)\right]}{20} = 1.60$$



$$w_a = o.w. + \frac{\sum area}{span} * w_s$$

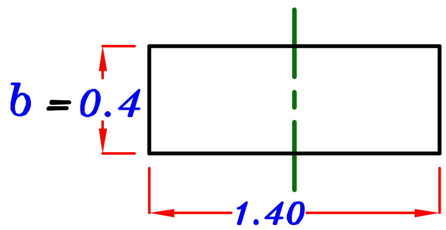
$$w_a = w_e = 15.0 + (1.6)(8.80)$$

$$= 29.1 \ \ kN\backslash m`$$

I_c

$$I_c = \frac{b(t)^3}{12} = \frac{0.4\,(1.40)^3}{12}$$

$$= 0.09146 \ m^4$$



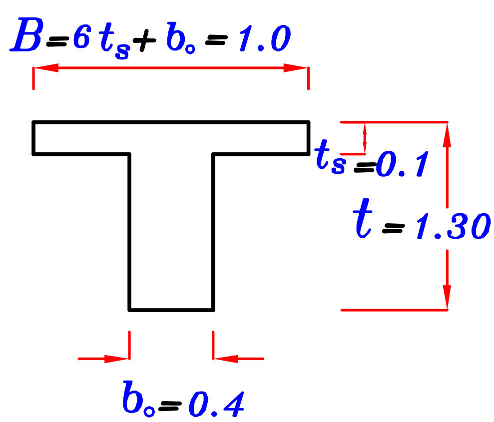
I_{b1}

$$\frac{t_s}{t} = \frac{0.1}{1.30} = 0.077$$

$$\frac{b_o}{B} = \frac{0.4}{1.0} = 0.40$$

From Tables page 91

$$\mu = 420.76$$

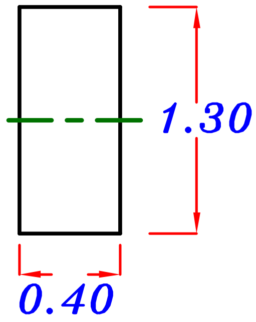


$$I_{b1} = (\mu * 10^{-4})\, B\, t^3 = 420.76 * 10^{-4} * 1.0 * 1.30^3$$

$$= 0.0924 \ m^4$$

I_{b2}

$$I_{b2} = \frac{b\,(t)^3}{12} = \frac{0.40\,(1.30)^3}{12} = 0.0732\ m^4$$



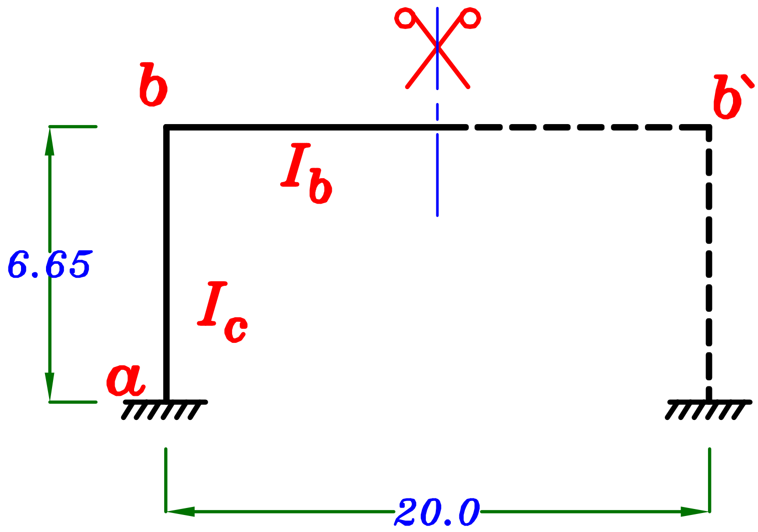
I_b

$$\boxed{I_b = \frac{I_{b1} * 2L_1 + I_{b2} * L_2}{2L_1 + L_2}}$$ نأخذ المتوسط

$$I_b = \frac{0.0924 * 16.0 + 0.0732 * 4.0}{16.0 + 4.0} = 0.08856$$

$$\therefore \boxed{I_b = 0.968\ I_c}$$

Distribution Factor.



D.F.

For Joint b

$$K_c = \frac{I_c}{h} = \frac{I_c}{6.65} = 0.150 I_c$$

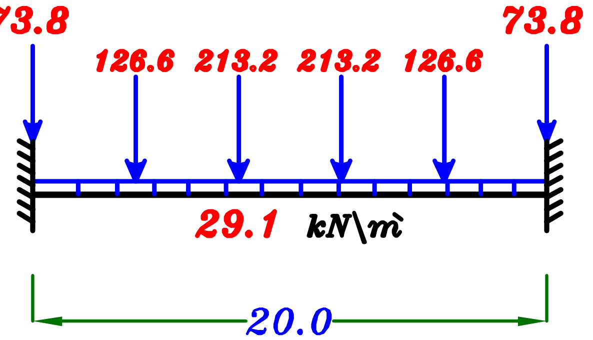
$$K_b = \frac{1}{2}\,\frac{I_b}{L} = \frac{1}{2} * \frac{(0.968) I_c}{20.0} = 0.0242\ I_c$$

$$D.F._c = \frac{0.150}{0.150 + 0.0242} = 0.861$$

$$D.F._b = 1 - 0.861 = 0.139$$

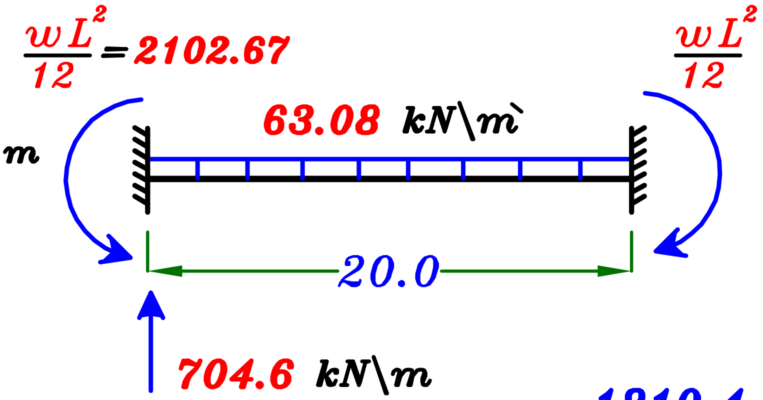
$$w = o.w. + \frac{\sum P}{span}$$

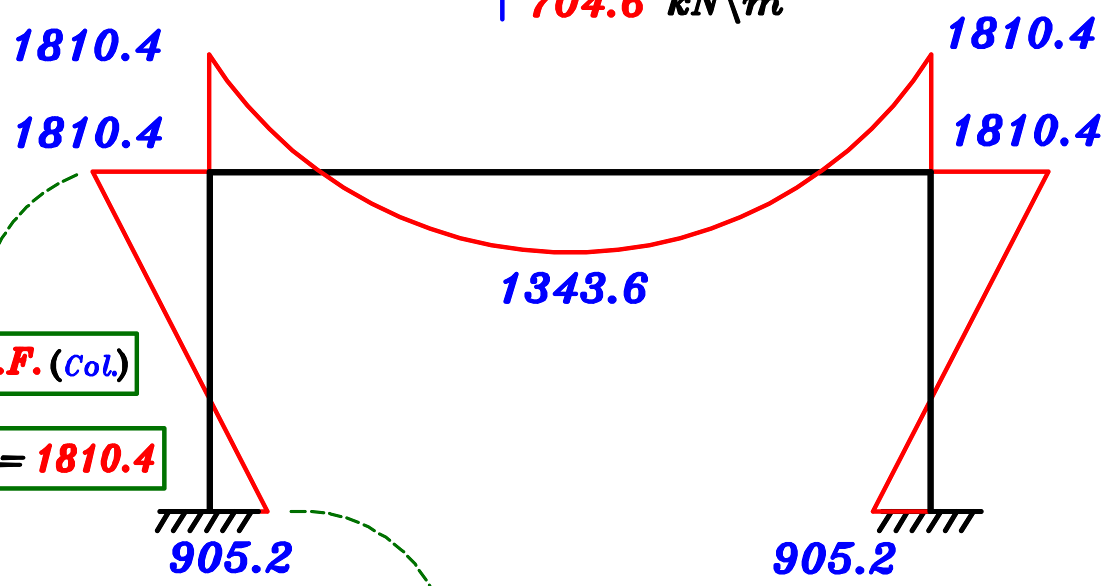
$$= 29.1 + \frac{2\,(126.6) + 2\,(213.2)}{20.0} = 63.08 \ kN\backslash m'$$



F.E.M.

$$\frac{wL^2}{12} = \frac{63.08 * (20.0)^2}{12} = 2102.67 \ kN.m$$

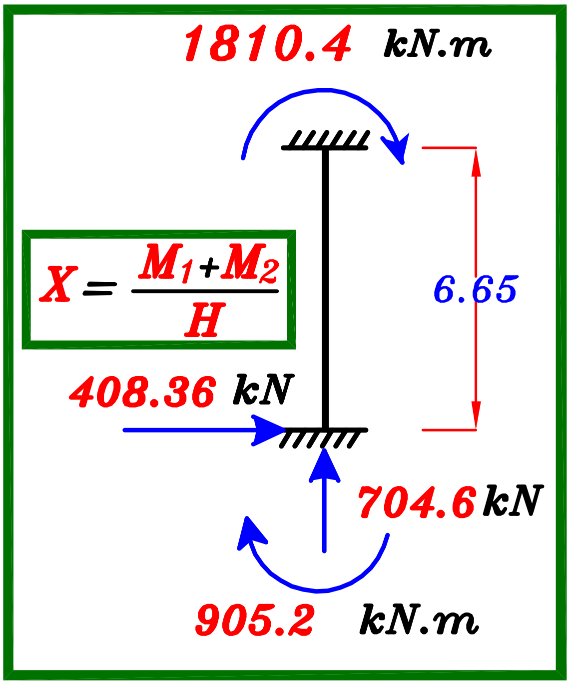


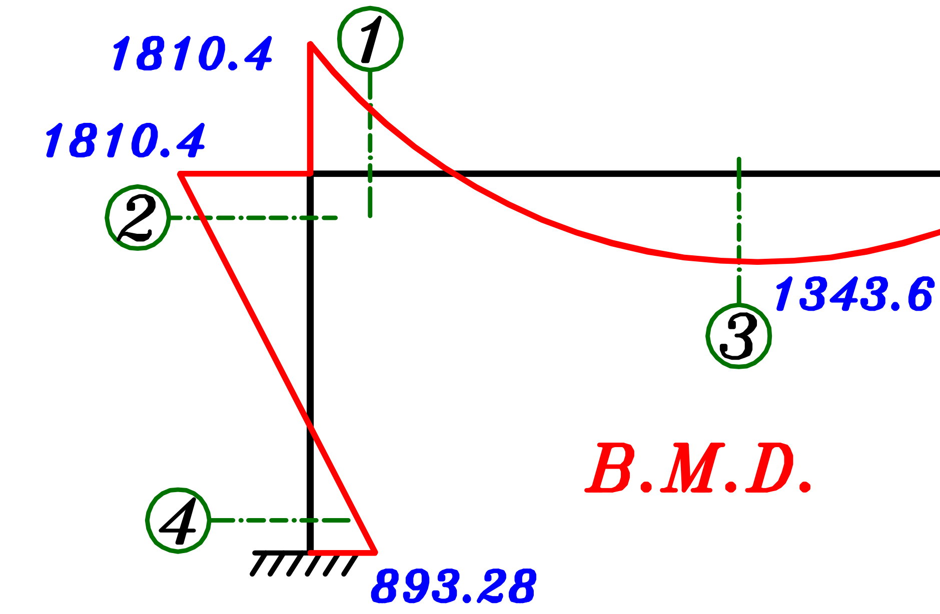


F.E.M. (Beam) * D.F. (Col.)

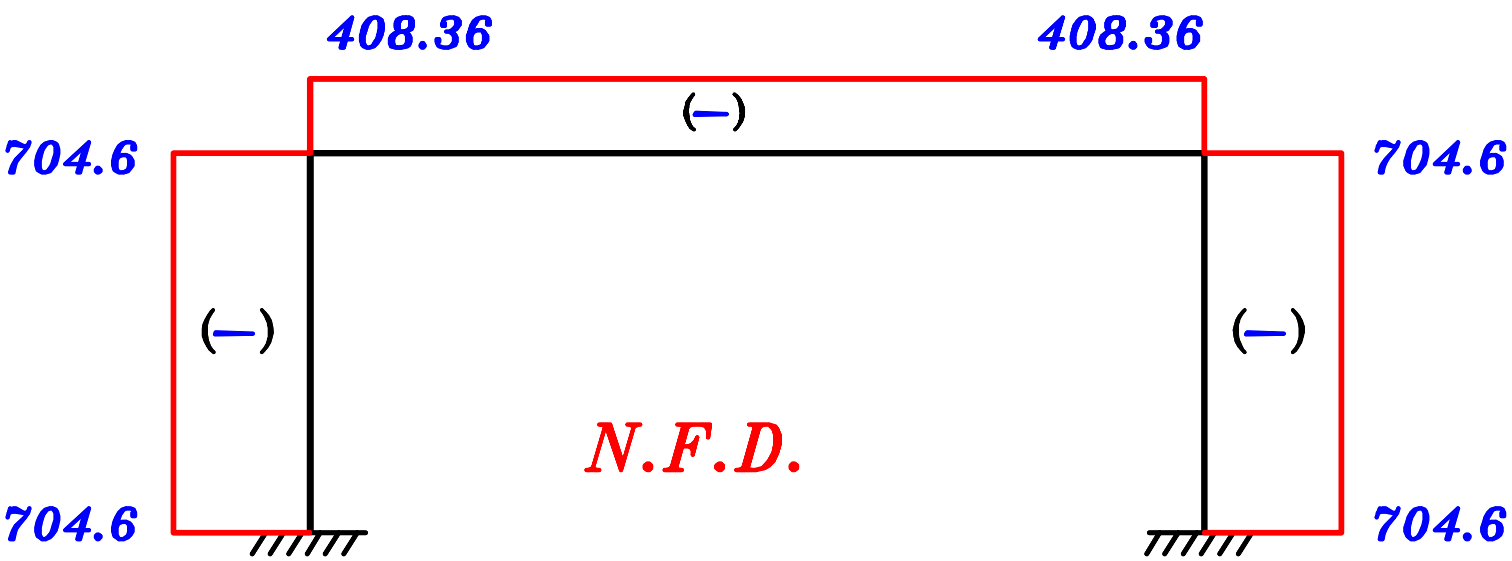
$2102.67 * 0.861 = 1810.4$

$\frac{1}{2}$ [F.E.M. (Beam) * D.F. (Col.)]





1810.4
1810.4
1
2
3
4
1343.6
B.M.D.
893.28



408.36
408.36
(−)
704.6
704.6
(−)
(−)
N.F.D.
704.6
704.6

Design of Sections.

Sec. ① R-Sec.

$M = 1810.4$ kN.m , $P = 408.36$ kN , $b = 400$ mm , $t = 1300$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{408.36 * 10^3}{25 * 400 * 1300} = 0.0314 < 0.04$ (neglect P)

$\therefore 1200 = C_1 \sqrt{\frac{1810.4 * 10^6}{25 * 400}} \longrightarrow C_1 = 2.82 \longrightarrow J = 0.730$

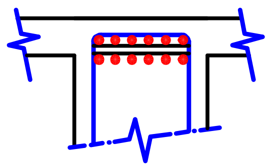
$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1810.4 * 10^6}{0.730 * 360 * 1200} = 5740.7\ mm^2$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 5740.7\ mm^2$

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1200 = 1640.6\ mm^2$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 5740.7\ mm^2$ $\quad 12\phi25$

$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{25 + 25} = 7.50 = 7.0$ bars



Sec. ② R-Sec.

Neglect Effect of Buckling.

$M = 1810.4$ kN.m , $P = 704.6$ kN , $b = 400$ mm , $t = 1300$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{704.6 * 10^3}{25 * 400 * 1300} = 0.054 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{1810.4}{704.6} = 2.57\ m$ $\qquad \therefore \frac{e}{t} = \frac{2.57}{1.3} = 1.97 > 0.5 \xrightarrow{use} e_s$

$$e_s = e + \frac{t}{2} - c = 2.56 + \frac{1.3}{2} - 0.1 = 3.12 \ m$$

$$M_s = P * e_s = 704.6 * 3.12 = 2198.35 \ kN.m$$

$$\therefore 1200 = C_1 \sqrt{\frac{2198.35 * 10^6}{25 * 400}} \longrightarrow C_1 = 2.56 < 2.78 \longrightarrow \text{Increase Dimensions.}$$

Take $t = 1400 \ mm \longrightarrow d = 1300 \ mm \ , \ b = 400 \ mm$

$$\therefore 1300 = C_1 \sqrt{\frac{2198.35 * 10^6}{25 * 400}} \longrightarrow C_1 = 2.78 \longrightarrow J = 0.717$$

$$\therefore A_s = \frac{M_s}{J \, F_y \, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{2198.35 * 10^6}{0.717 * 360 * 1300} - \frac{704.6 * 10^3}{(360 \backslash 1.15)}$$

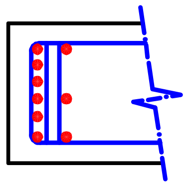
$$= 4300.5 \ mm^2$$

Check $As_{min.}$ $\qquad A_{s_{req.}} = 4300.5 \ mm^2$

$$\mu_{min.} \, b \, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b \, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.} b \, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 4300.5 \ mm^2 \qquad 9 \phi 25$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{25 + 25} = 7.50 = 7.0 \text{ bars}$$



Sec. ③ R-Sec.

$M = 1343.6 \ kN.m \ , \ P = 408.36 \ kN \ , \ b = 400 \ mm \ , \ t = 1300 \ mm$

Check $\dfrac{P}{F_{cu} \, b t} = \dfrac{408.36 * 10^3}{25 * 400 * 1300} = 0.0314 < 0.04$ (neglect P)

$$\therefore 1200 = C_1 \sqrt{\frac{1343.6 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.27 \longrightarrow J = 0.768$$

$$\therefore A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{1343.6 * 10^6}{0.768 * 360 * 1200} = 4049.7\ mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 4049.7\ mm^2$

$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1200 = 1640.6\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\,b\,d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 4049.7\ mm^2 \qquad 9\,\phi 25$$

Sec. ④ R-Sec. $\qquad$ Neglect Effect of Buckling.

$M = 905.2\ kN.m$, $P = 704.6\ kN$, $b = 400\ mm$, $t = 1400\ mm$

$$\text{Check } \frac{P}{F_{cu}\,b\,t} = \frac{704.6 * 10^3}{25 * 400 * 1400} = 0.0503 > 0.04 \quad (\text{Don't neglect } P)$$

$$e = \frac{M}{P} = \frac{905.2}{704.6} = 1.267\ m \qquad \therefore \frac{e}{t} = \frac{1.267}{1.40} = 0.905 > 0.5 \xrightarrow{use} e_s$$

$$e_s = e + \frac{t}{2} - c = 1.267 + \frac{1.4}{2} - 0.1 = 1.867\ m$$

$$M_s = P * e_s = 704.6 * 1.867 = 1315.49\ kN.m$$

$$\therefore 1300 = C_1 \sqrt{\frac{1315.49 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.584 \longrightarrow J = 0.786$$

$$\therefore A_s = \frac{M_s}{J\,F_y\,d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{1315.49 * 10^6}{0.786 * 360 * 1300} - \frac{704.6 * 10^3}{(360 \backslash 1.15)} = 1325.37\ mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s\,req.} = 1325.37\ mm^2$

$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625\ mm^2$$

$$\therefore \mu_{min.}\,b\,d > A_{s\,req.} \xrightarrow{Use} A_{s\,min.}$$

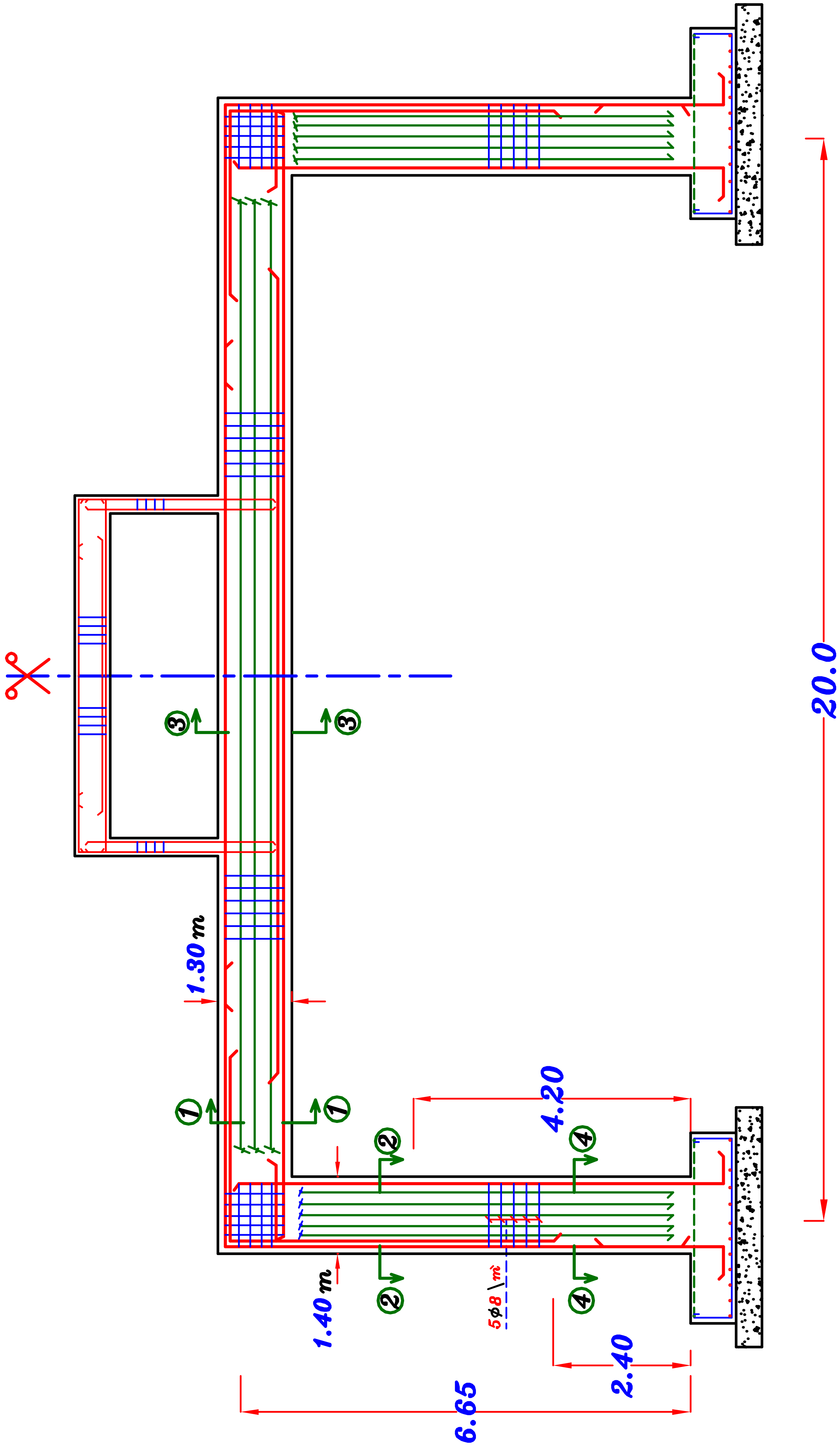
$$A_{s\,min.} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\,b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1300 = 1625$$

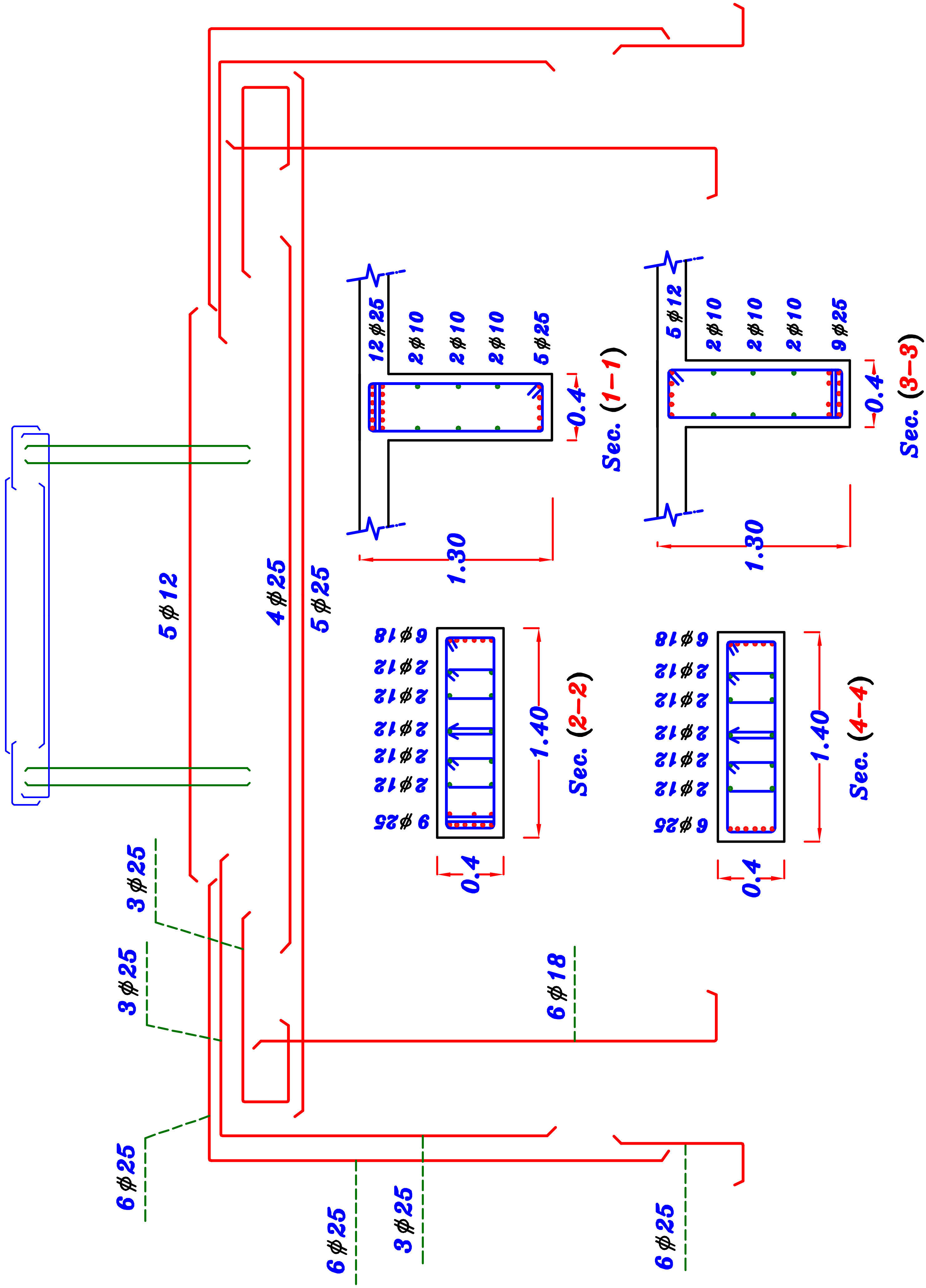
$$1.3\,A_{s_{req.}} = 1.3 * 1325.37 = 1722.98$$

الأقل $= 1625$

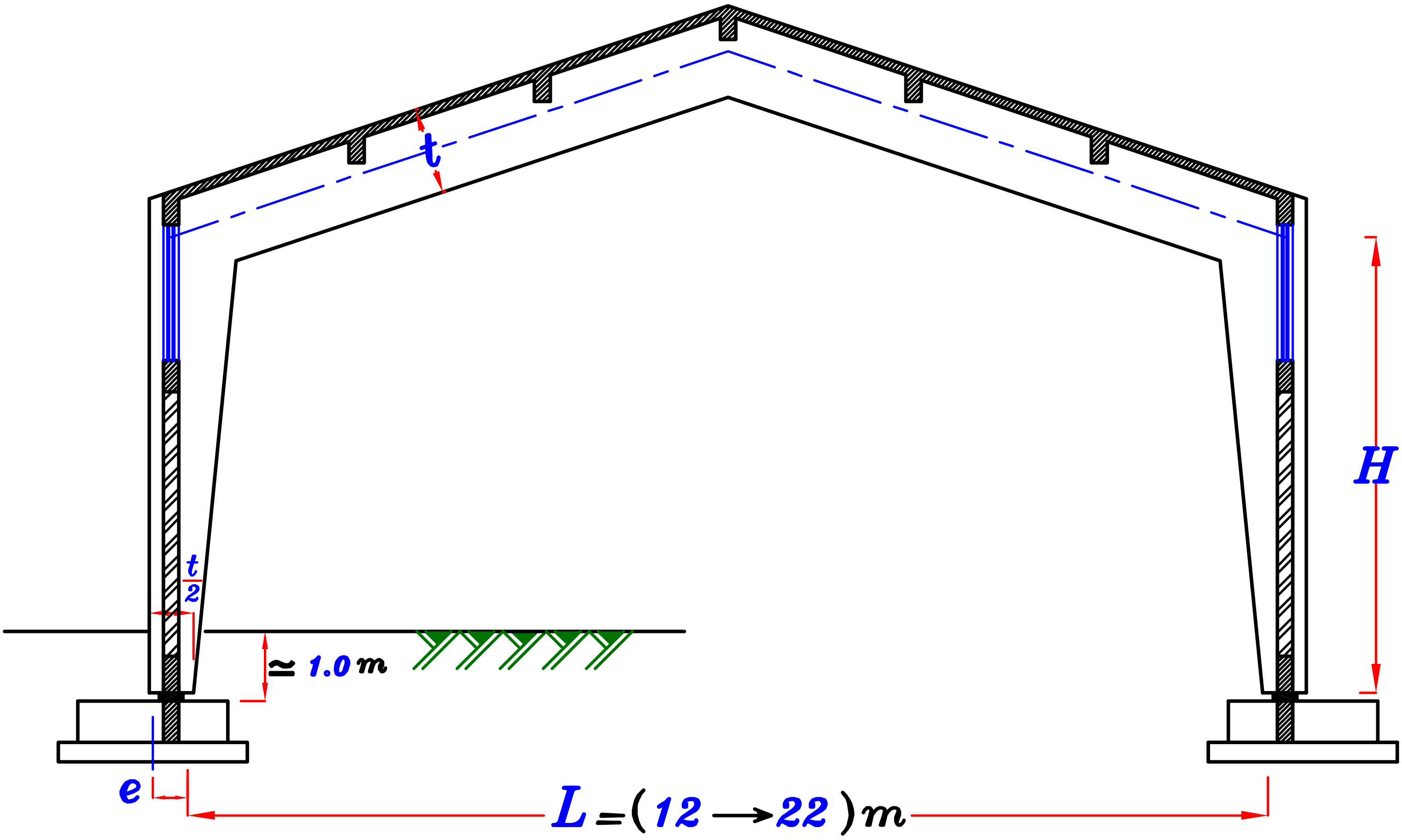
st. 360/520 $\qquad \frac{0.15}{100}\,b\,d = \frac{0.15}{100} * 400 * 1300 = 780\ mm^2$

الأكبر $= 1625\ mm^2$ $\qquad 6\,\phi 18$


20.0
1.30 m
1.40 m
4.20
2.40
6.65
5φ8 \m`
1
2
3
4


5 φ 12
4 φ 25
5 φ 25
12 φ 25
2 φ 10
2 φ 10
2 φ 10
5 φ 25
0.4
Sec. (1-1)
1.30
5 φ 12
2 φ 10
2 φ 10
2 φ 10
9 φ 25
0.4
Sec. (3-3)
1.30
6 φ 18
2 φ 12
2 φ 12
2 φ 12
2 φ 12
2 φ 12
9 φ 25
1.40
Sec. (2-2)
0.4
6 φ 18
2 φ 12
2 φ 12
2 φ 12
2 φ 12
2 φ 12
6 φ 25
1.40
Sec. (4-4)
0.4
3 φ 25
3 φ 25
6 φ 18
6 φ 25
6 φ 25
3 φ 25
6 φ 25

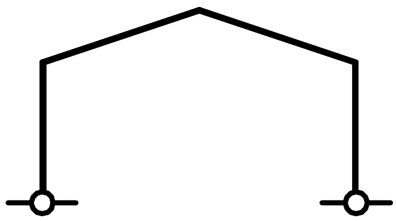
Two Hinged Inclined Frame.



– Statical System

The 2 hinged Frame is

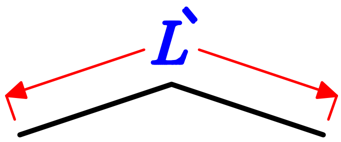
Once Statically indeterminate structure



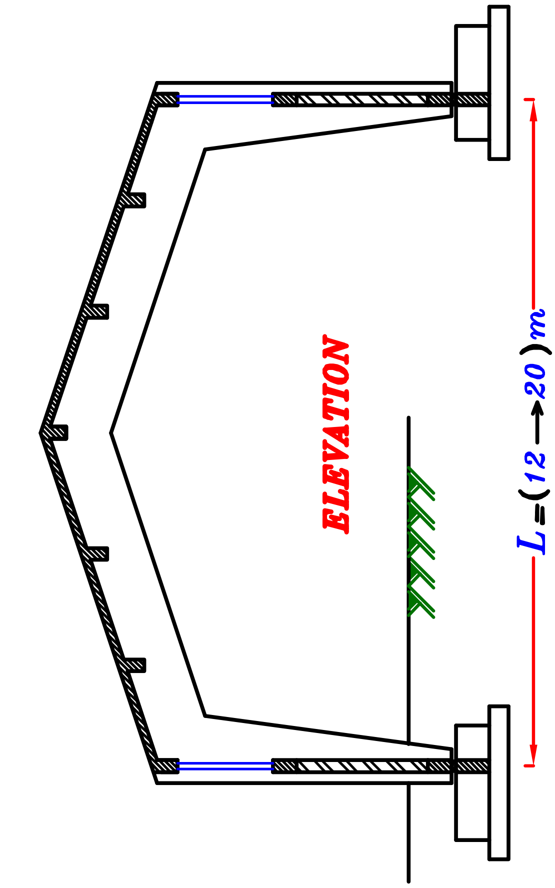
– Concrete Dimensions.

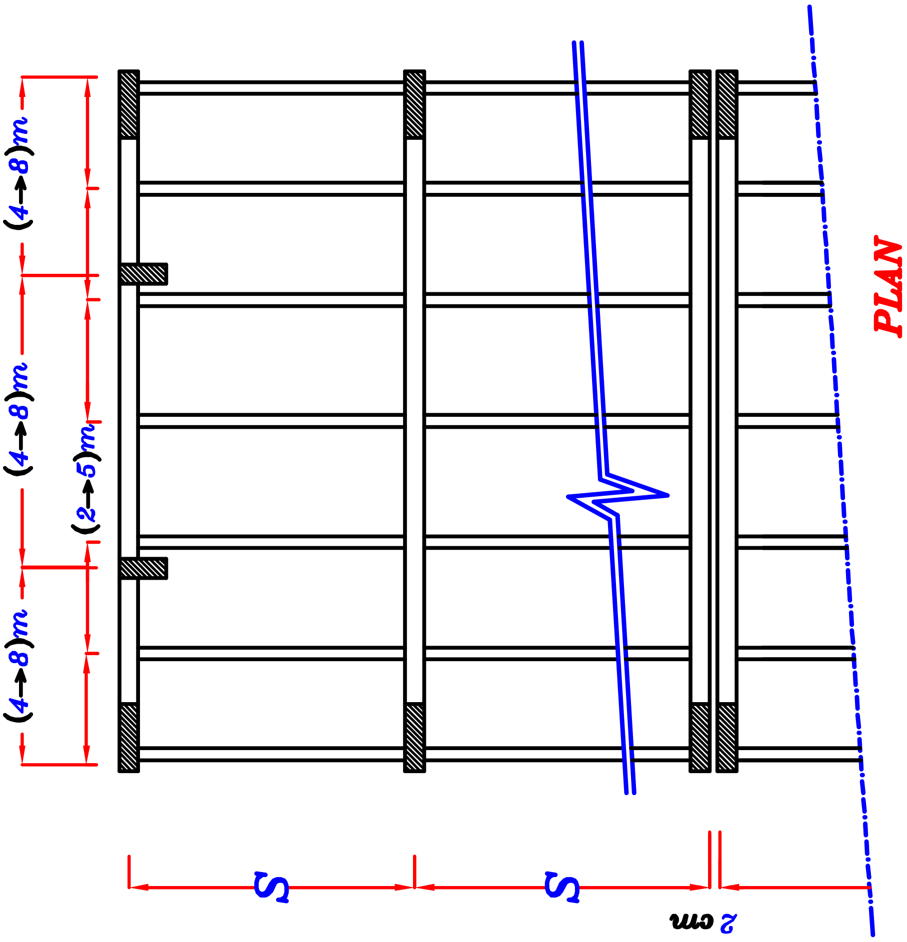
* Span (L) = (12 → 22) m

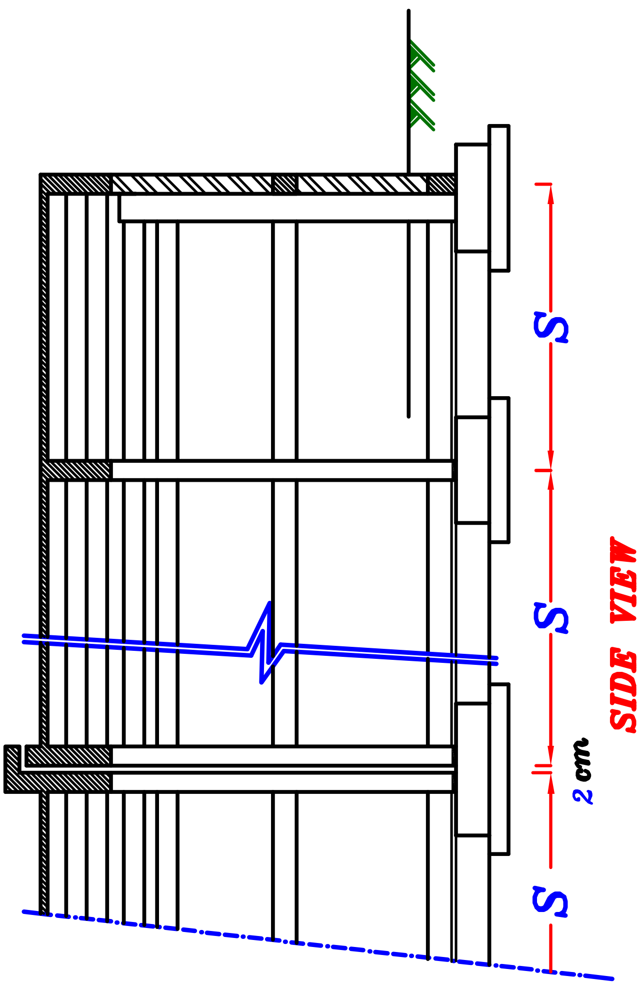
* $t \simeq \dfrac{L'}{12 \rightarrow 14}$

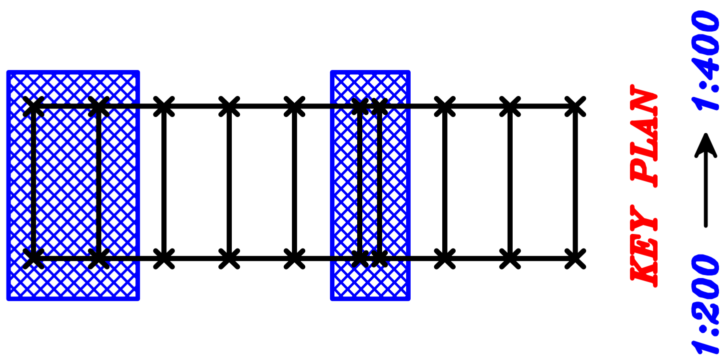


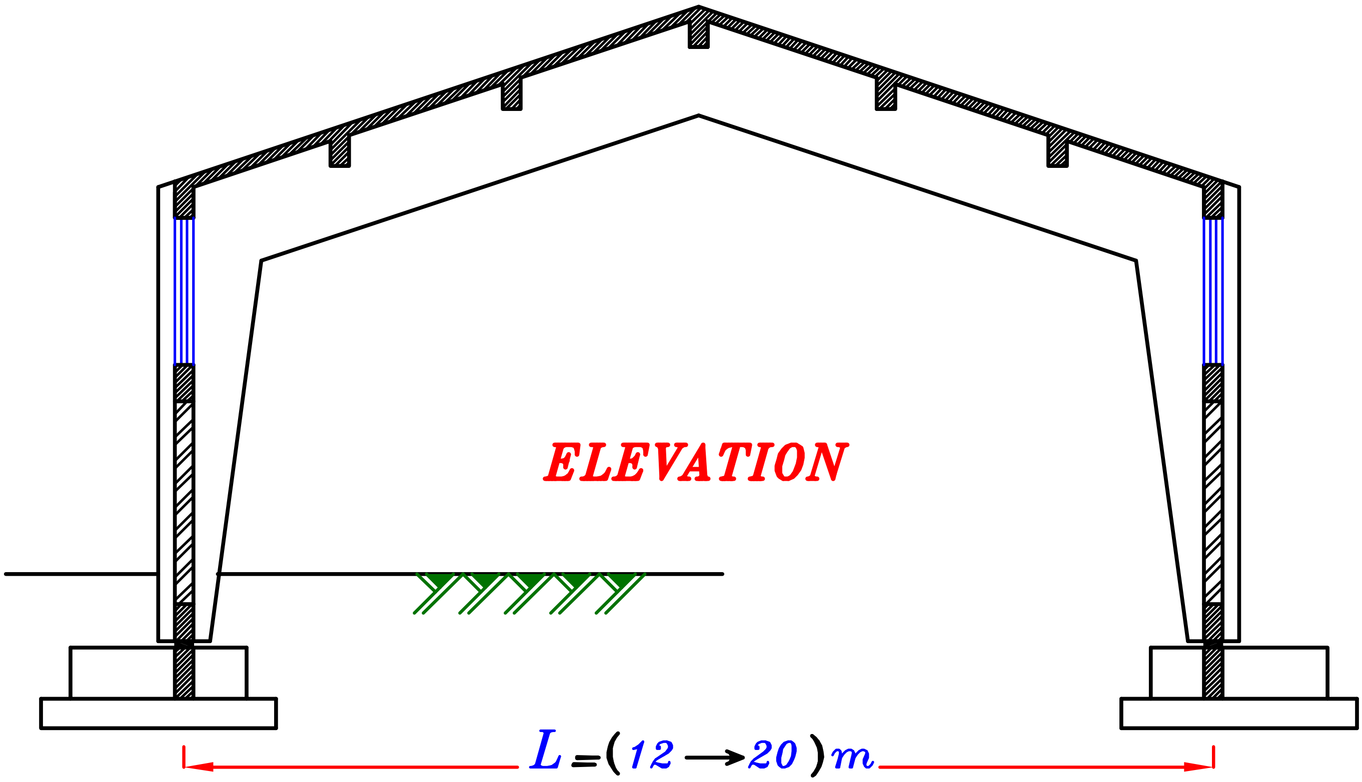
* $b = \left. \begin{array}{l} 0.30\ m \\ \dfrac{\text{Spacing}}{20} \end{array} \right\}$ الأكبر

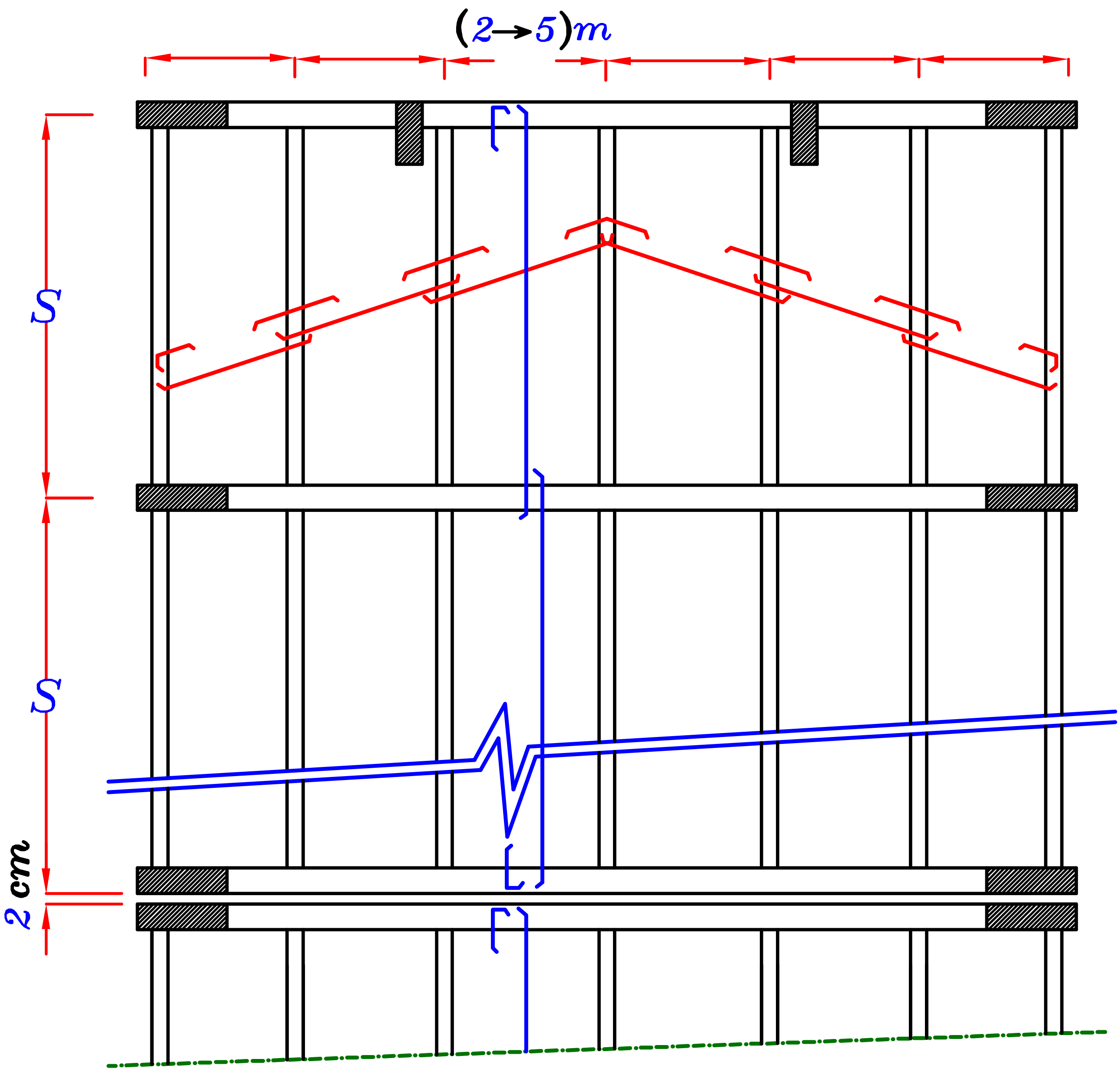

ELEVATION
L =(12 →20) m


PLAN
(4→8)m
(4→8)m
(4→8)m
(2→5)m
S
S
2 cm


SIDE VIEW
S
S
S
2 cm


KEY PLAN
1:200 → 1:400


ELEVATION
L =(12 → 20)m

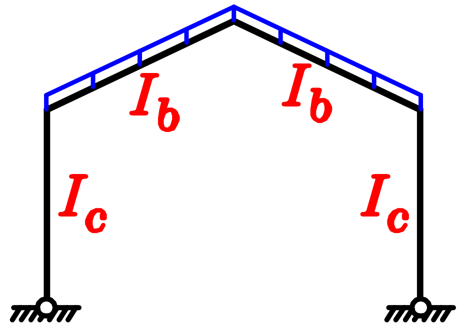

(2→5)m
S
S
2 cm
PLAN

Solving the Inclined Frame.

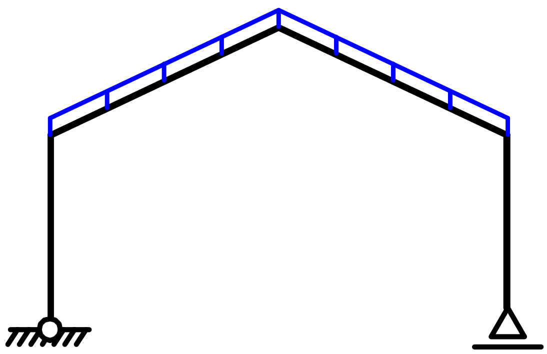
نظرا لوجود Sway على ال Frame
لذا الاسهل حله ب Virtual work

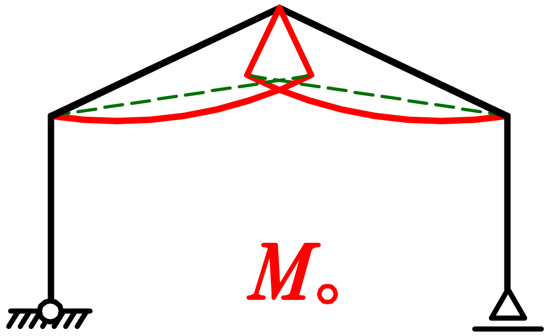
Virtual work method.

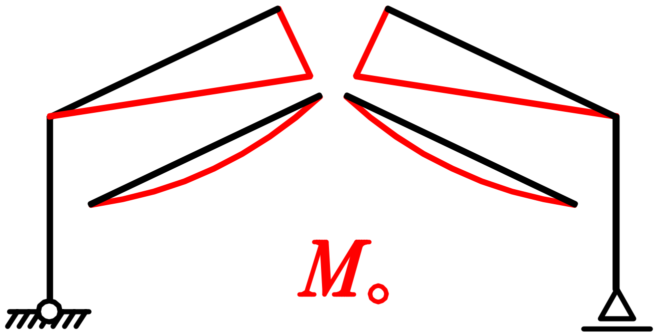
ⓐ Get Moment of Inertia For all members. « I »

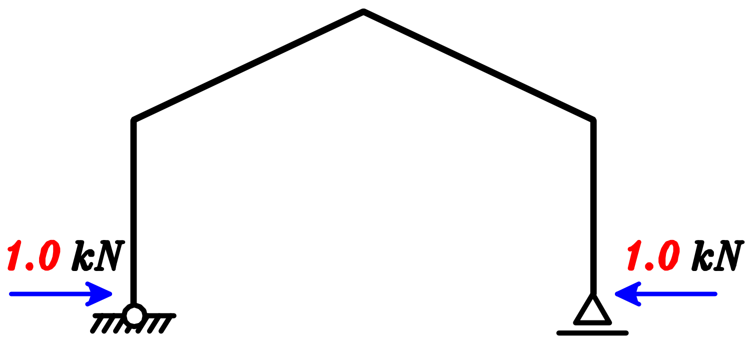


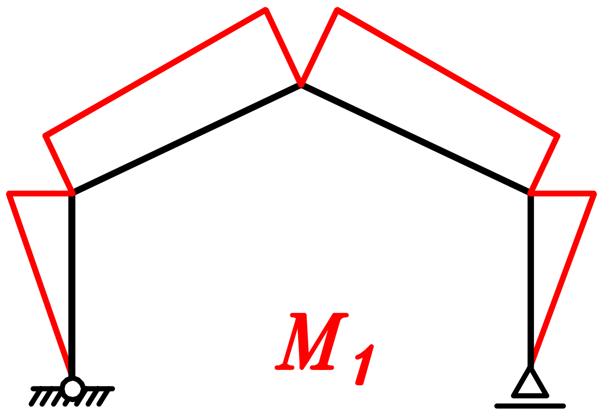
ⓑ Make the Frame Determinate and Draw B.M.D. « M_o »











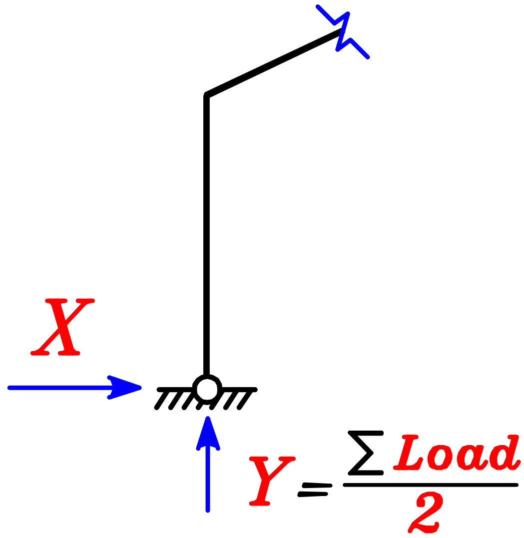
© Calculate the deflections. δ_{10} & δ_{11}

$$\delta_{10} = \frac{1}{E_c I_b} * (M_o * M_1) + \frac{1}{E_c I_c} * (M_o * M_1)$$

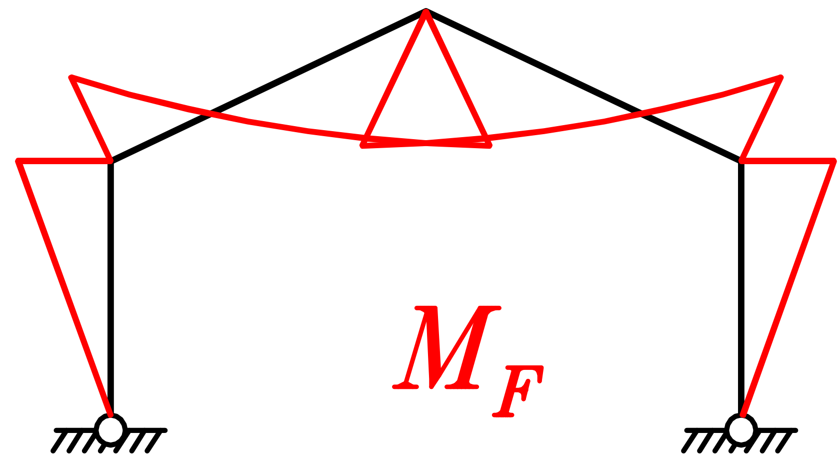
$$\delta_{11} = \frac{1}{E_c I_b} * (M_1 * M_1) + \frac{1}{E_c I_c} * (M_1 * M_1)$$

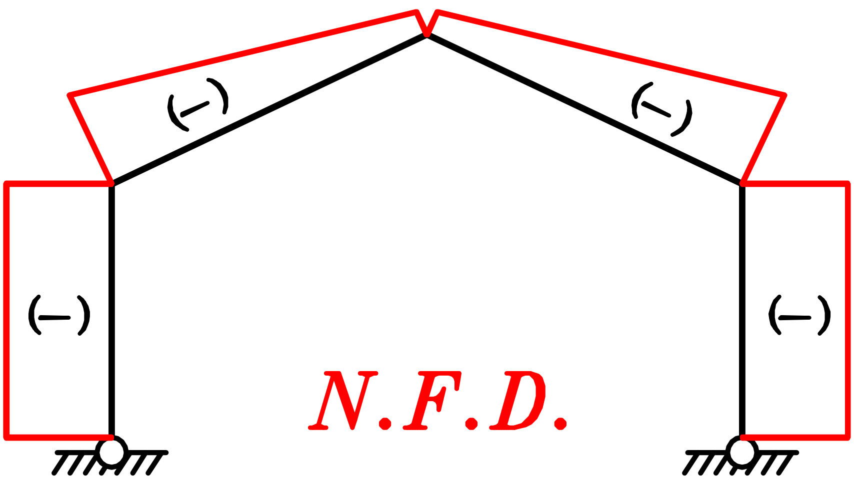
$$\boxed{\delta_{10} + X\ \delta_{11} = Zero}$$

Get X

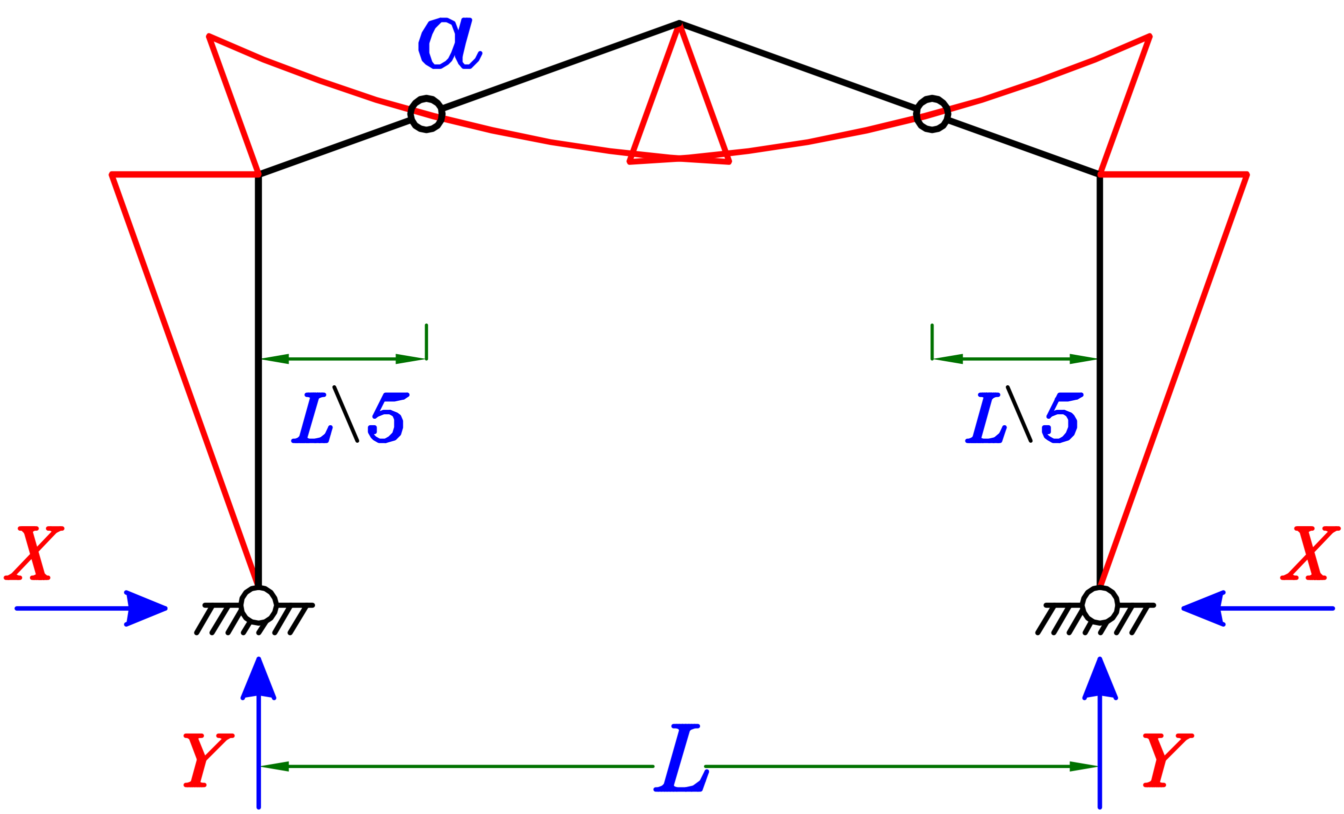


$$\boxed{M_F = M_o + X\ M_1}$$





Approximate Solution.



assume that in the beam there is an intermediate hinge at $\frac{L}{5}$

$$Y = \frac{\sum Loads}{2}$$

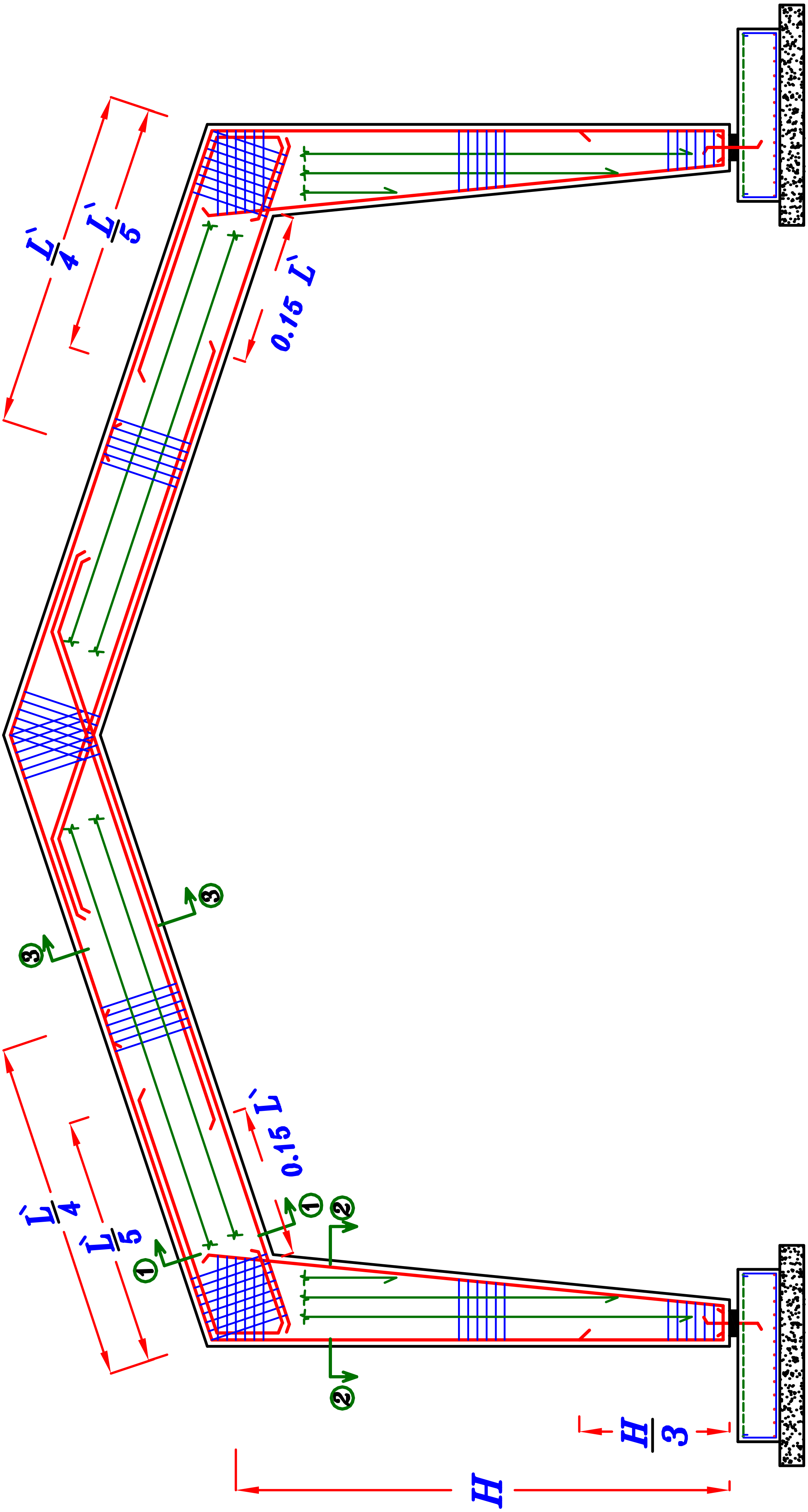
To get the reactions X

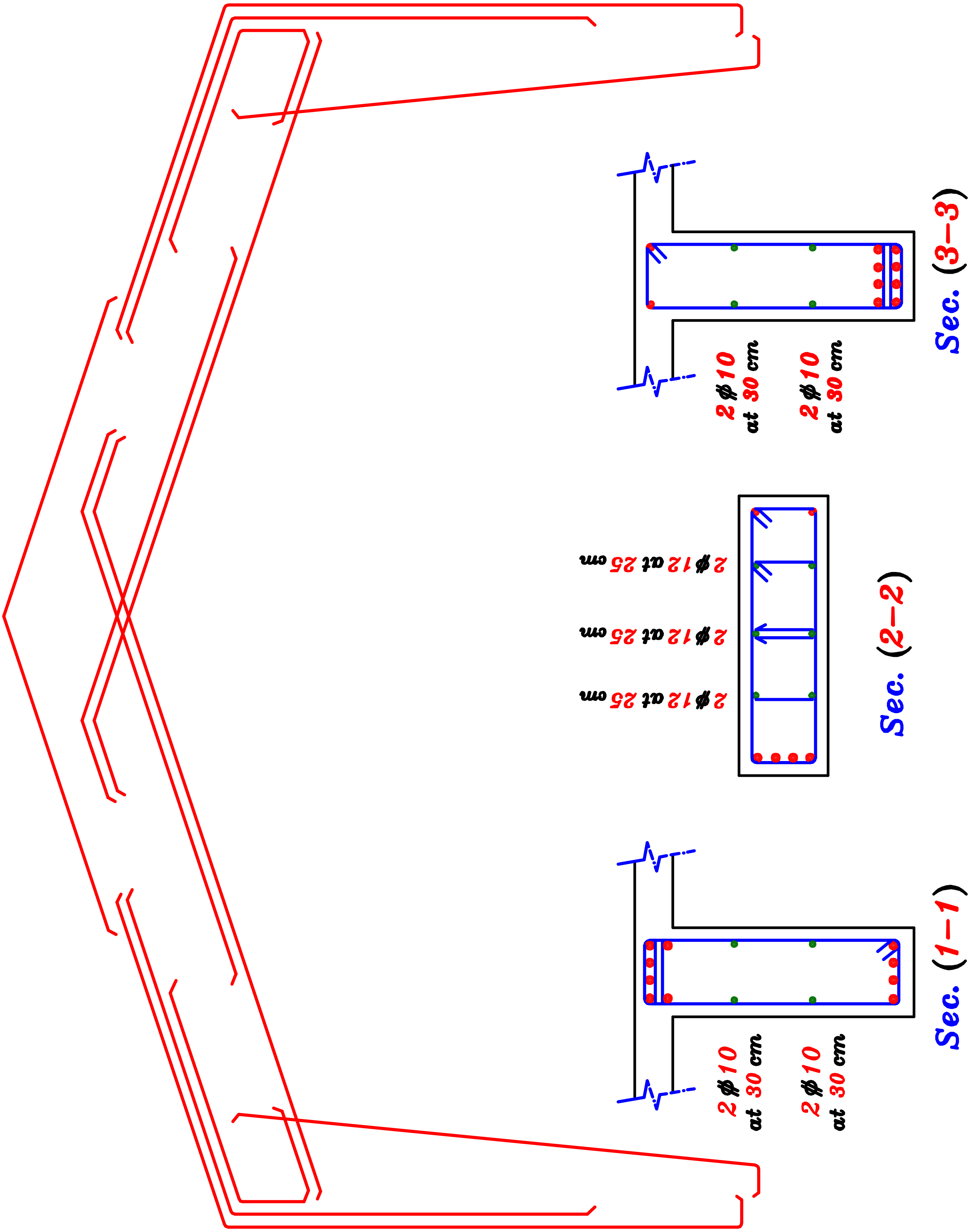
Take the moment at Point a = Zero

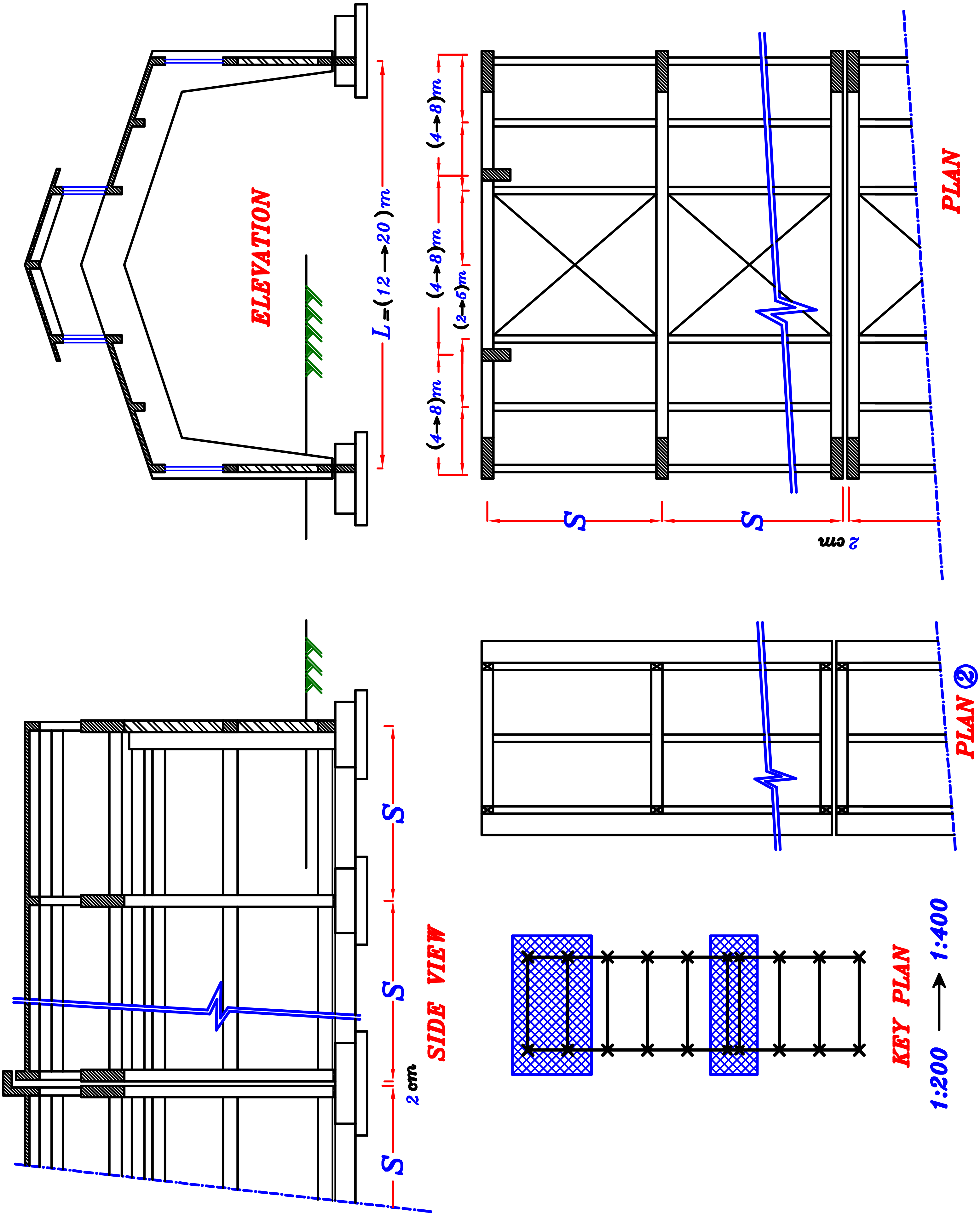
Then Draw Internal Forces Diagrams.

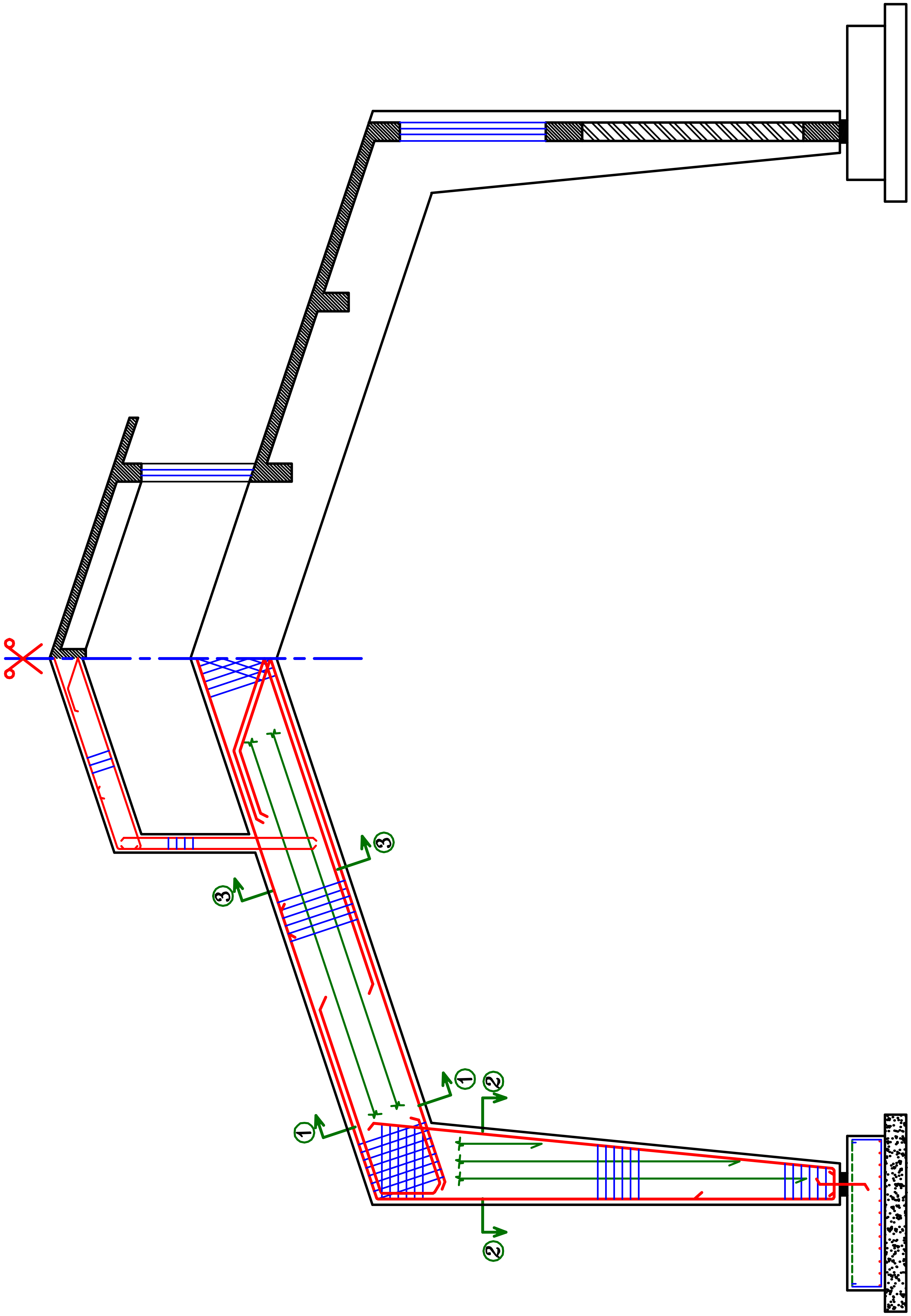
ملحوظه هامه

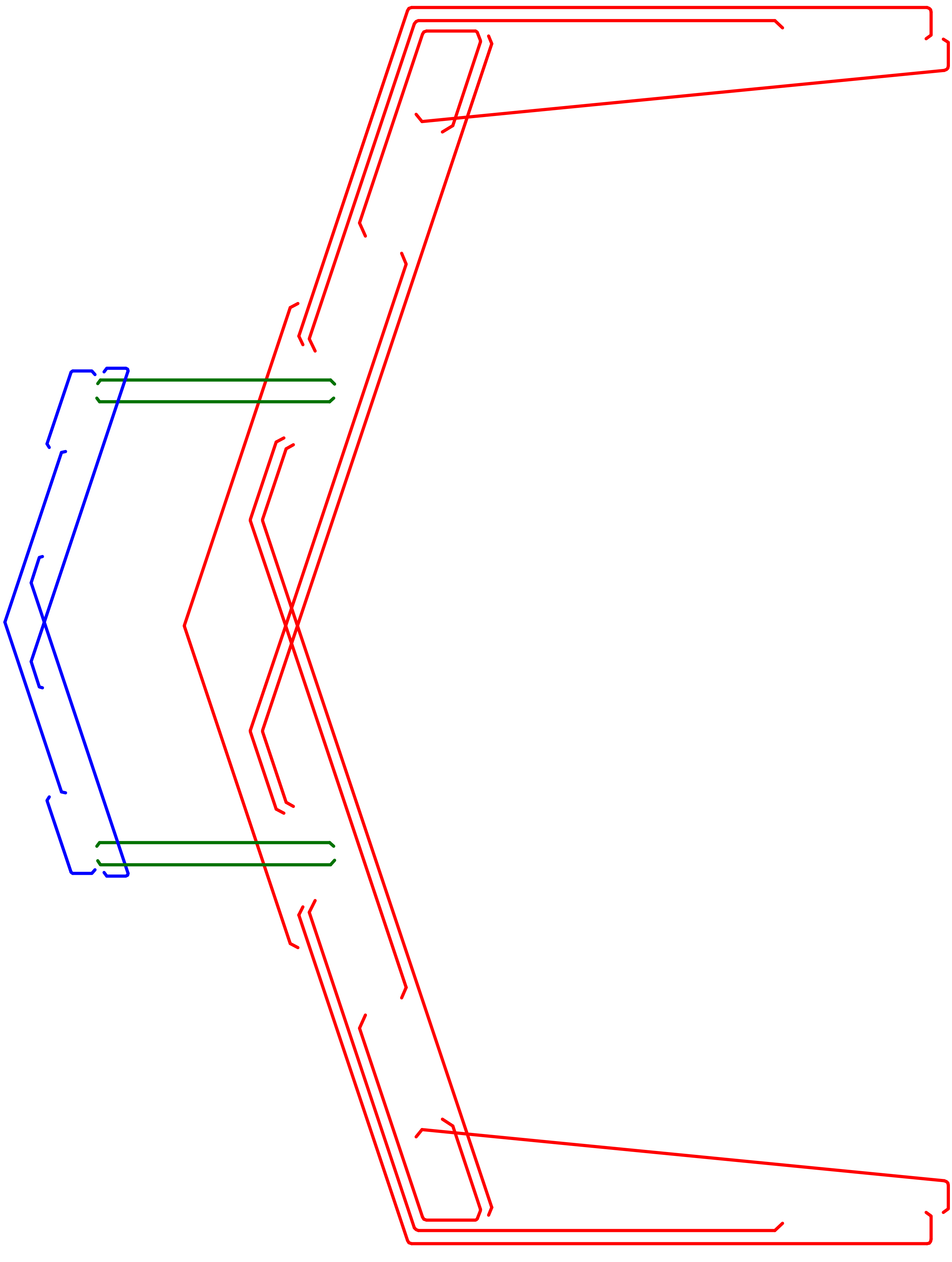
هذا الحل حل تقريبى جدا و غير دقيق ، لذا لن نستخدم هذا الحل الا مع تعذر الوقت فى الامتحان


Ĺ/4
Ĺ/5
0.15 Ĺ
H
H/3
1
2
3

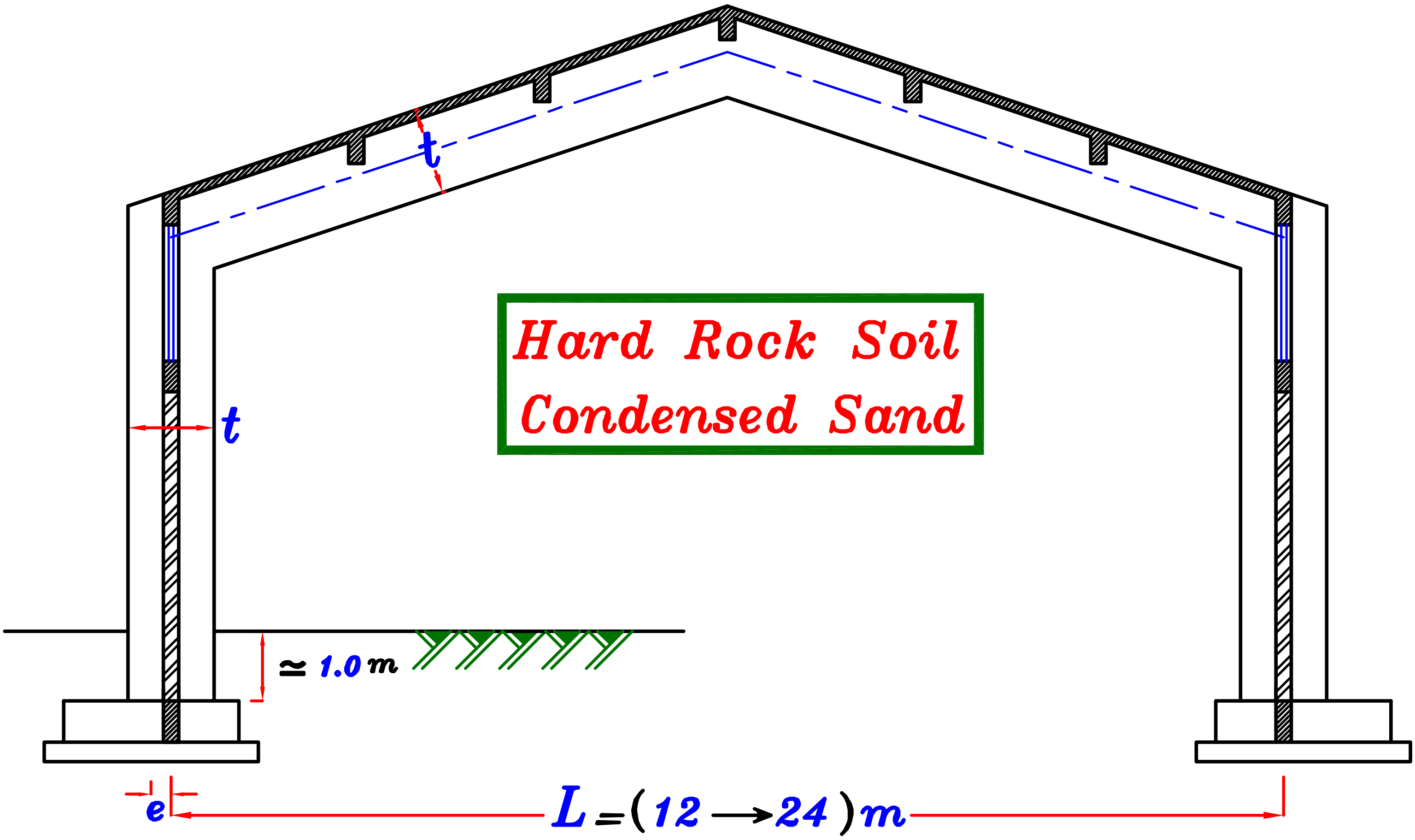

Sec. (3-3)
2 ϕ10 at 30 cm
2 ϕ10 at 30 cm
Sec. (2-2)
2 ϕ12 at 25 cm
2 ϕ12 at 25 cm
2 ϕ12 at 25 cm
Sec. (1-1)
2 ϕ10 at 30 cm
2 ϕ10 at 30 cm


ELEVATION
L=(12→20)m
PLAN
(4→8)m
(4→8)m
(2→5)m
(4→8)m
S
S
2 cm
PLAN ②
SIDE VIEW
S
S
S
2 cm
KEY PLAN
1:200 → 1:400





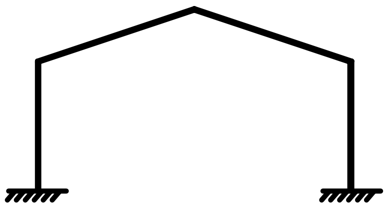
Inclined Fixed Frame.



- **Statical System**

The Fixed Frame is Two Times Statically indet.

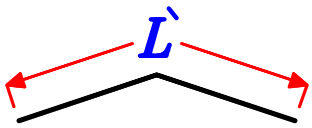
symmetric لانه



- **Concrete Dimensions.**

* Span (L) = (12 → 24) m

* $t \simeq \dfrac{L'}{14 \to 16}$



* b = $\left.\begin{array}{l} 0.30\ m \\ \dfrac{\text{Spacing}}{20} \end{array}\right\}$ الأكبر

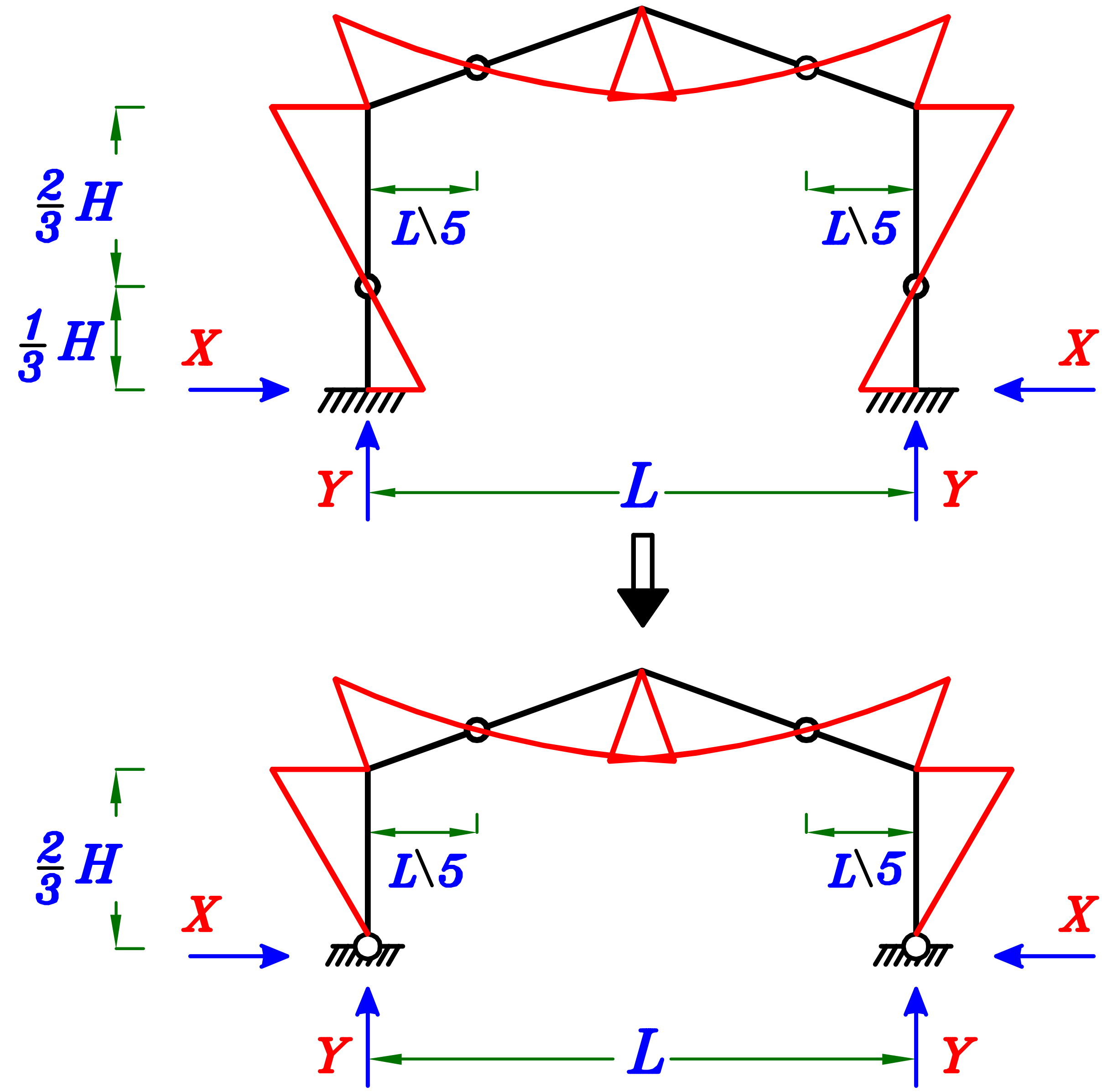
Solving Inclined Fixed Frames.

لان ال Fixed Inclined Frame عليه sway فسيكون حله بال moment distribution صعب جدا

و لانه Twice staticaly indeterminate فسيكون حله بال Virtual work صعب جدا

لذا فى الكليه سنضطر حله ب Approximate method و هذا بالطبع حل تقريبى جدا .

Approximate Method.



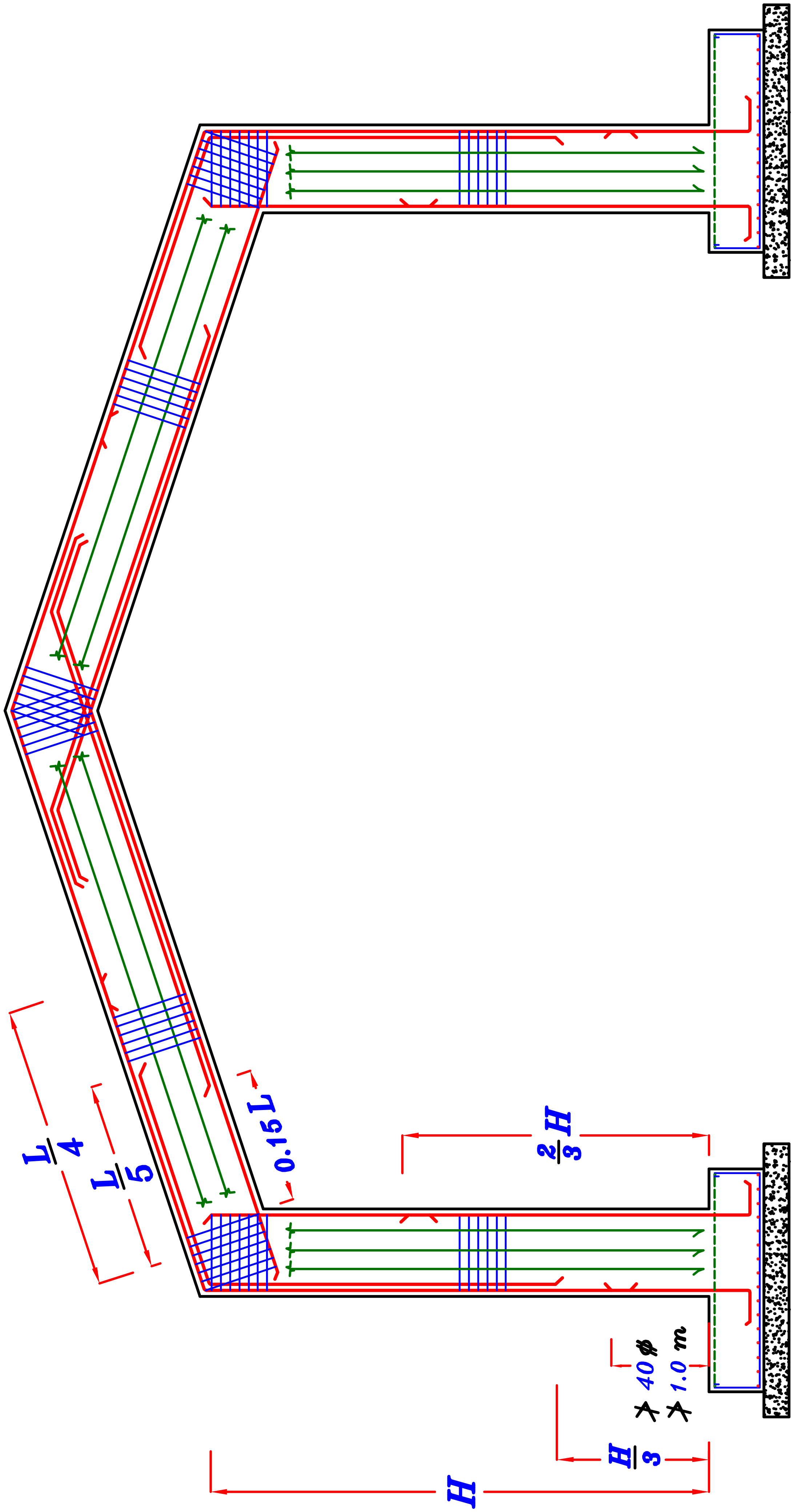
assume that in the column there is an intermediate hinge at $\frac{H}{3}$

so we can solve the Frame as Two hinged Frame but with height $\frac{2}{3}H$

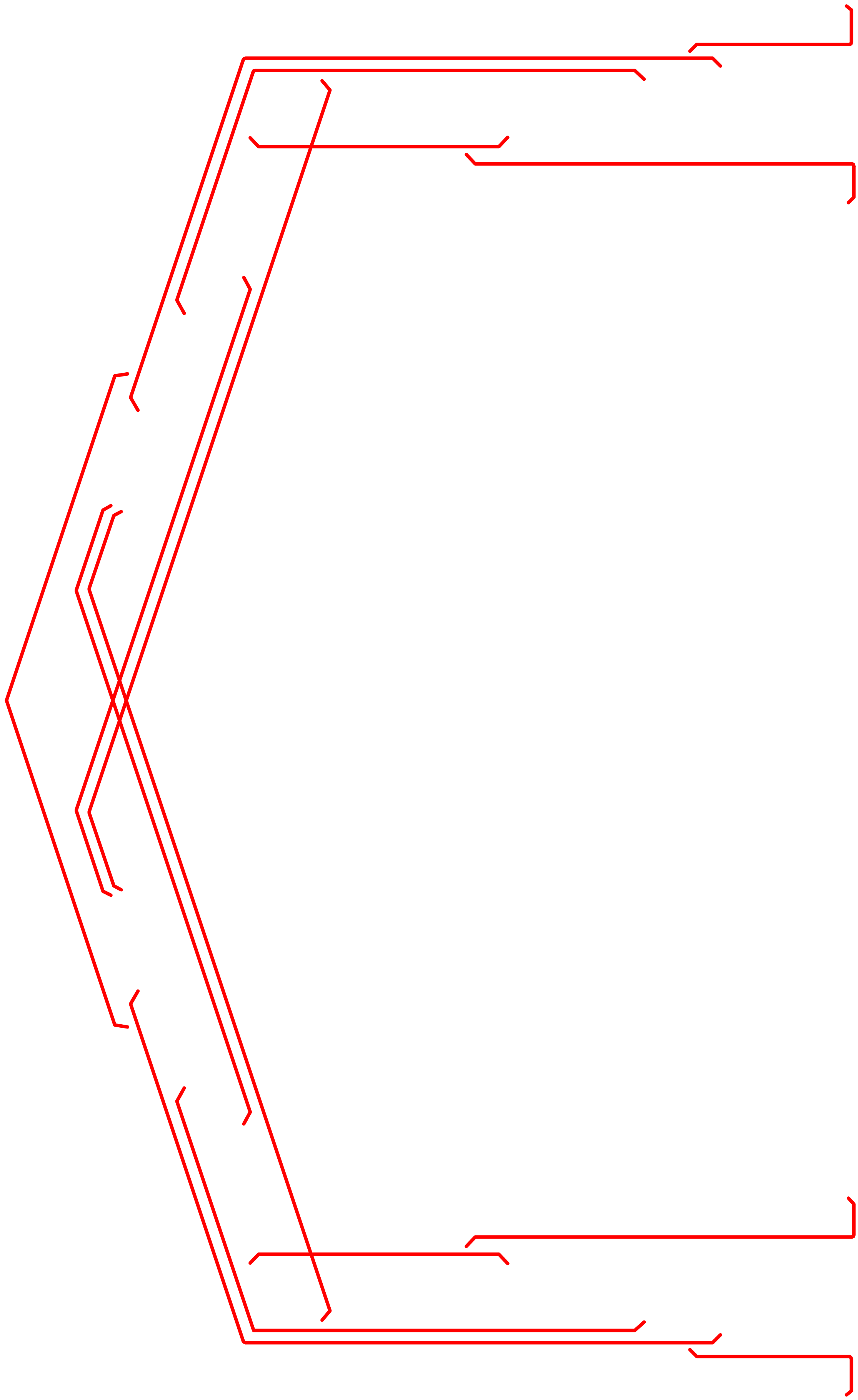
assume that in the beam there is an intermediate hinge at $\frac{L}{5}$

$$Y = \frac{\sum Loads}{2}$$

To get the reactions X Take the moment at Point $a = Zero$



L/4
L/5
0.15 L
2/3 H
> 40 φ
> 1.0 m
H/3
H

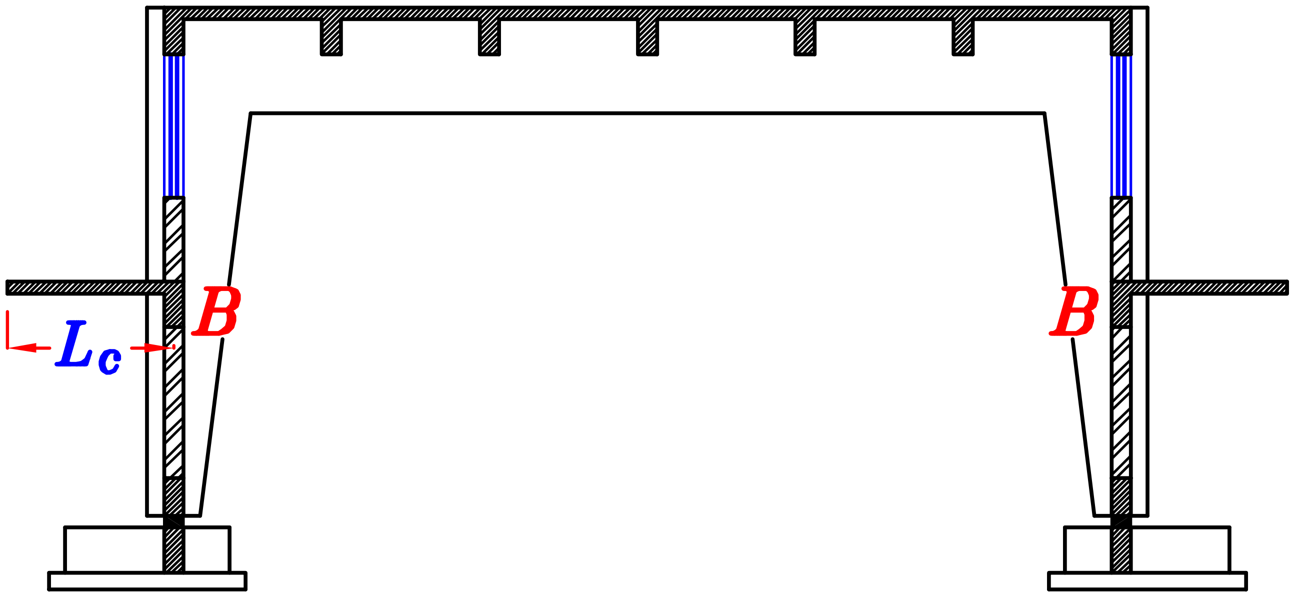


Special Case.

توجد حالتان :

اذا وجد cantilever خارج من عمود ال Frame

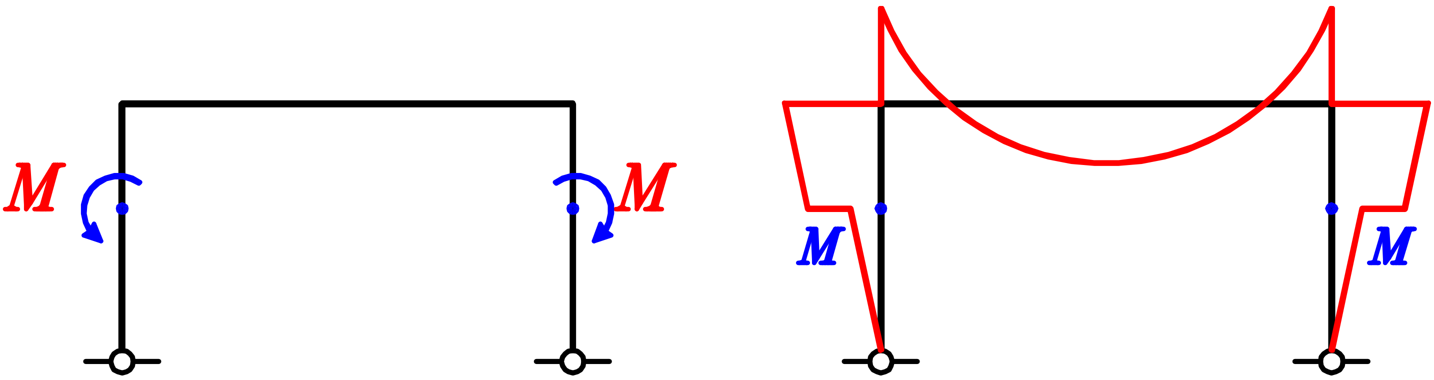
1- IF $L_c \leqslant 2.0 \xrightarrow{Use}$ Cantilever Slab



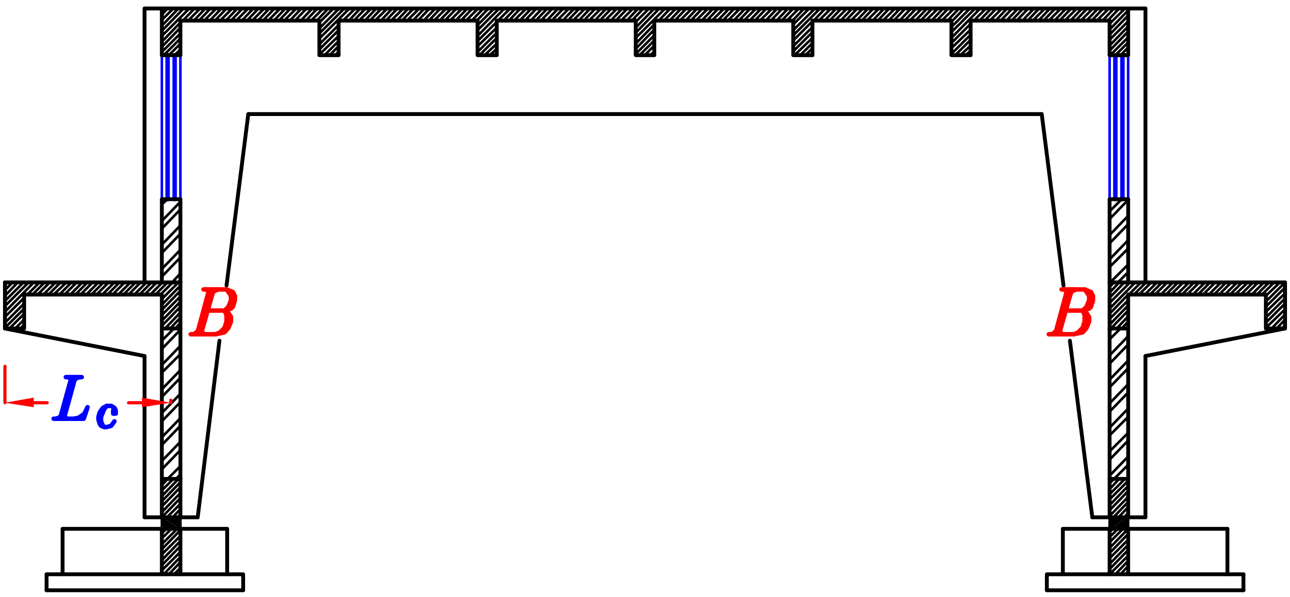
و فى هذه الحاله يوجد Torsion على الكمره B

يتحول الى Concentrated bending moment

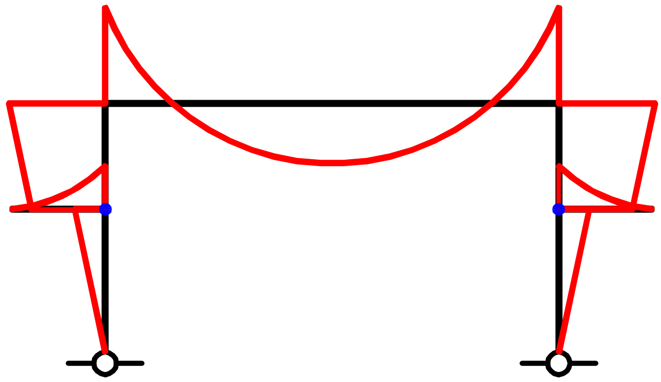
على عمود ال Frame $\boxed{M = \left(\frac{w_s * L_c^2}{2}\right) * Spacing}$



2- IF $L_c > 2.0 \xrightarrow{Use}$ Cantilever Frame



و فى هذه الحاله لا يوجد Torsion على الكمره B



فى حاله وجود Cantilever سواء كان Cantilever Slab or Cantilever Frame

لن تتفع معادله Moment distribution

$$\boxed{M = F.E.M.(Beam) * D.F.(Col.)}$$

لذا سنضطر حل ال Frame

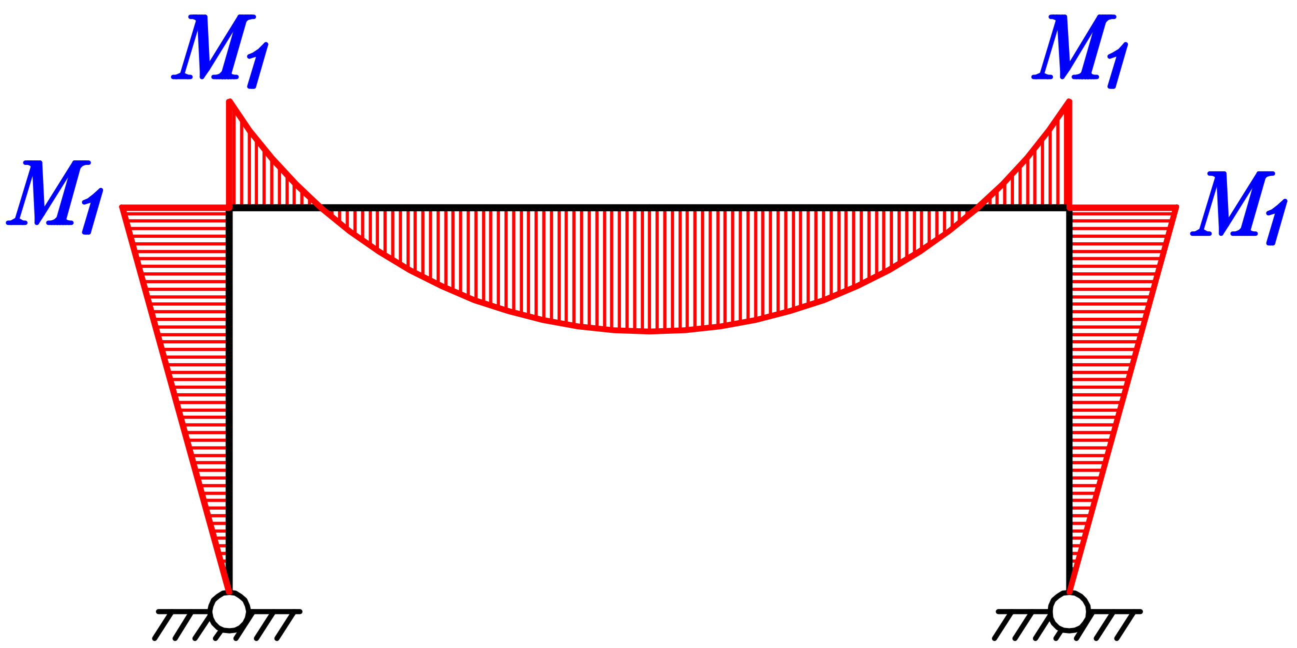
اما عن طريق Moment distribution لكن بجدول

او عن طريق Virtual Work

ممكن للتسهيل

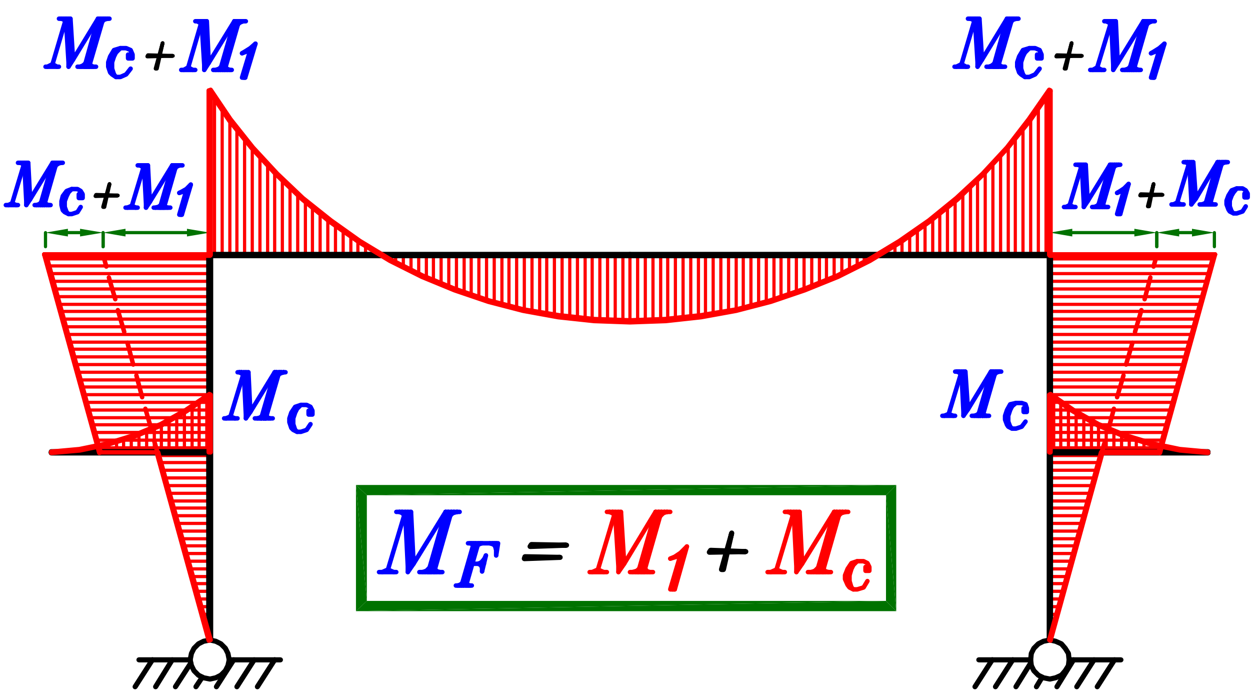
عند وجود cantilever خارج من ال symetric Frame

١- حل ال Frame بدون cantilever



$$\boxed{M_1 = F.E.M._{(beam)} * D.F._{(col.)}}$$

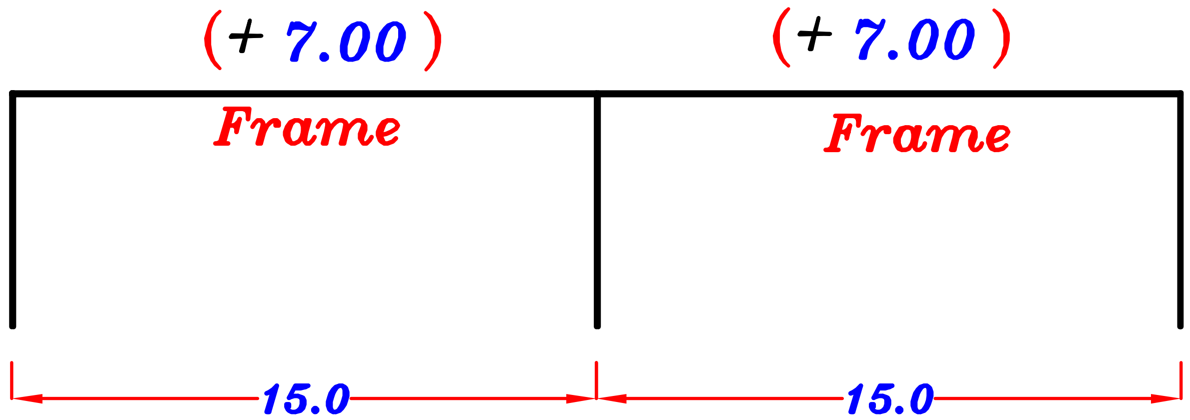
٢- حساب قيمة العزم النهائى $M_F = M_1 + M_c$



$$\boxed{M_F = M_1 + M_c}$$

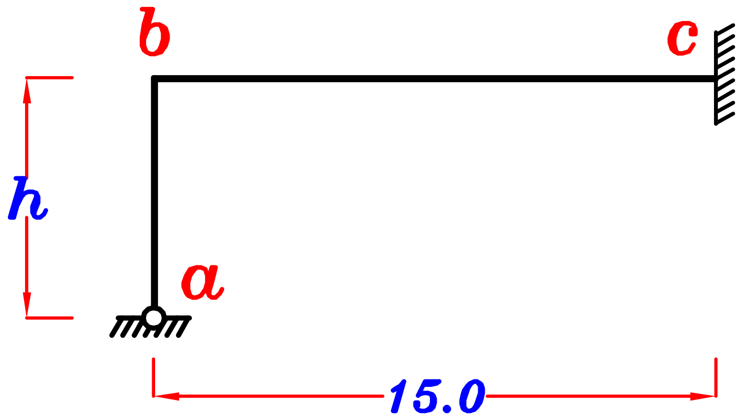
Applications Of Frames.

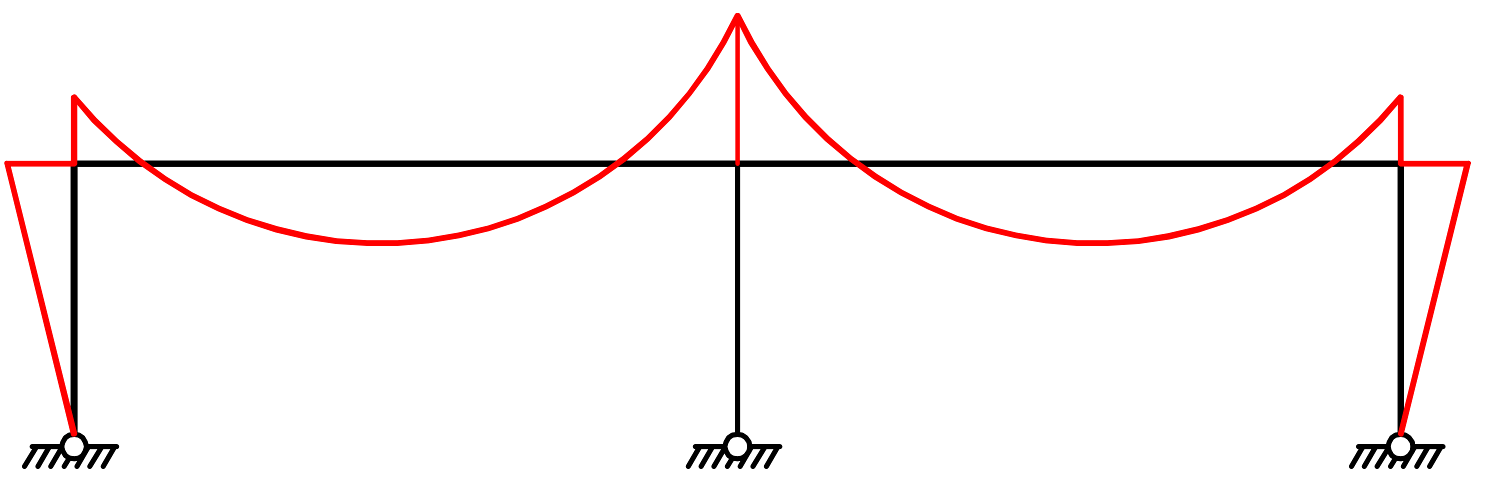
Continuous Frame.

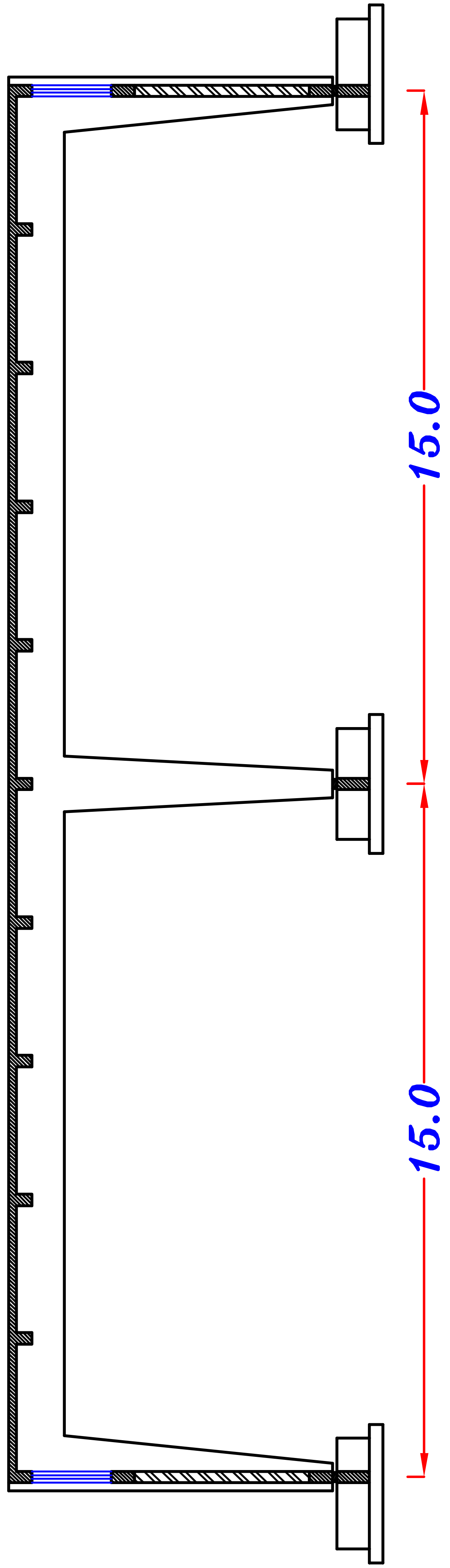


لكى نستطيع أن نحل هذا ال *Frame* بطريقه *moment distribution*
يجب أن يكون *Frame symmetric*

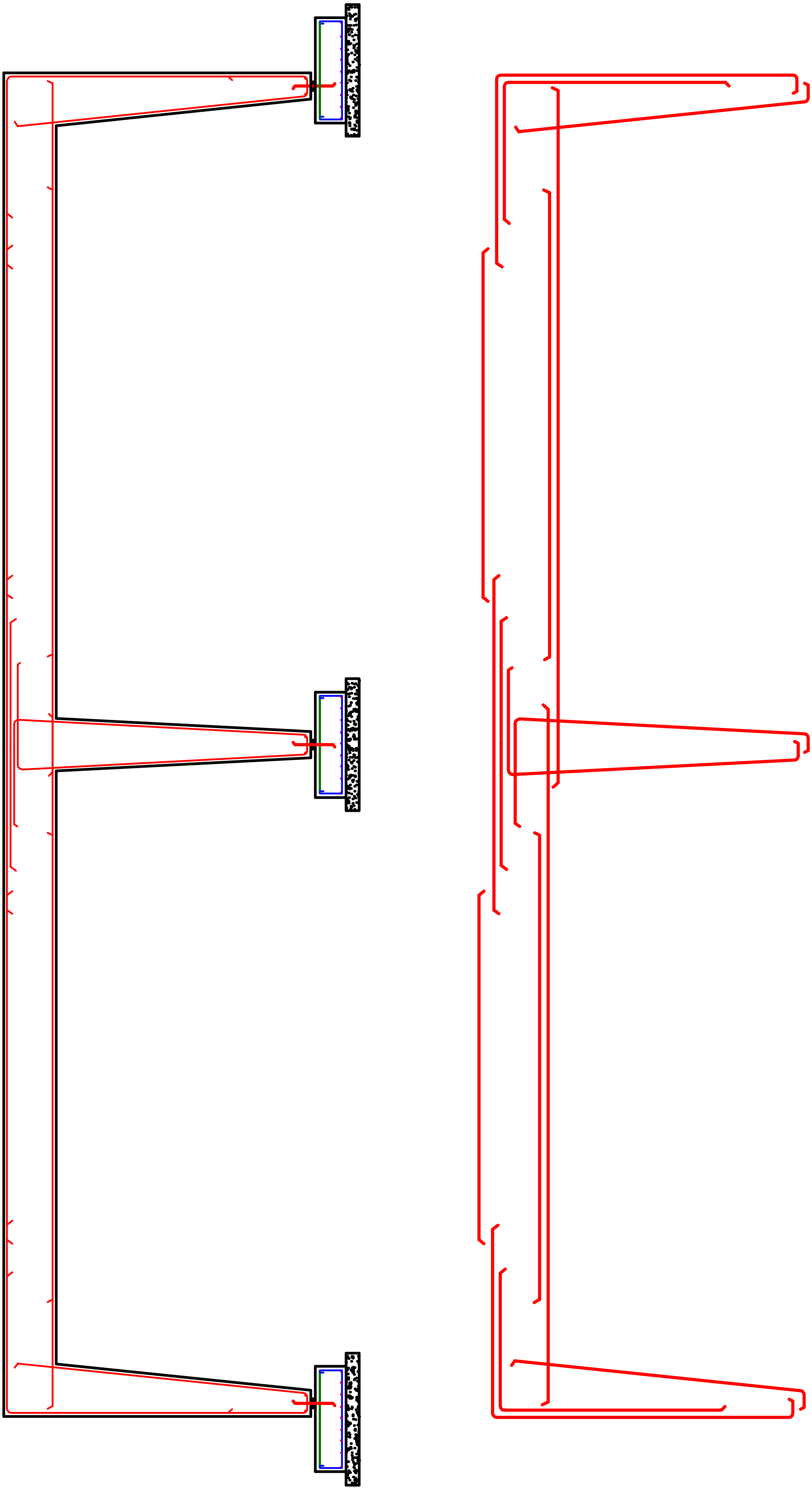
Joints	b		c
members	b–a	b–c	c–b
D.F.	✓	✓	—
F.E.M.	—	✓	✓
B.M.	✓	✓	—
C.O.M	—	—	✓
B.M.	—	—	—
M_F	✓	✓	✓







Continuous Hinged Frame



Example.

Figure (1) shows the plan of a roof covering a bus shed (20 m * 9 m). Four columns only are allowed and marked by ✕ . Live Load plus roof Finish (L.L.+F.C.) = 3.0 kN/m^2

Concrete Characteristic strength is 25 MPa

Steel grade is 400/600 For main RFT.

Steel grade is 240/350 For stirrups.

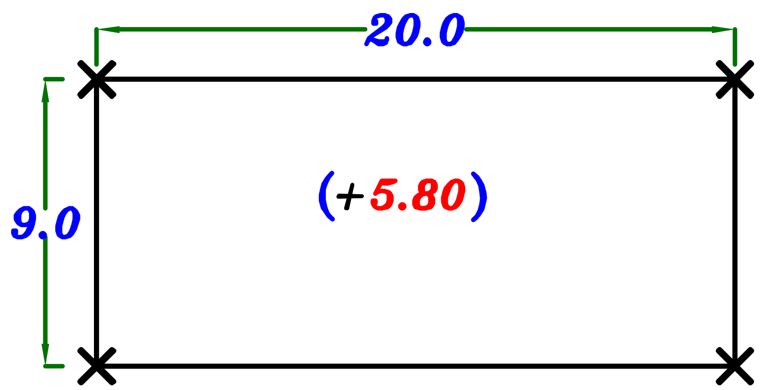
Required :

1 – Draw plan and elevation showing the concrete dimensions of the slabs, beams and the main supporting elements.

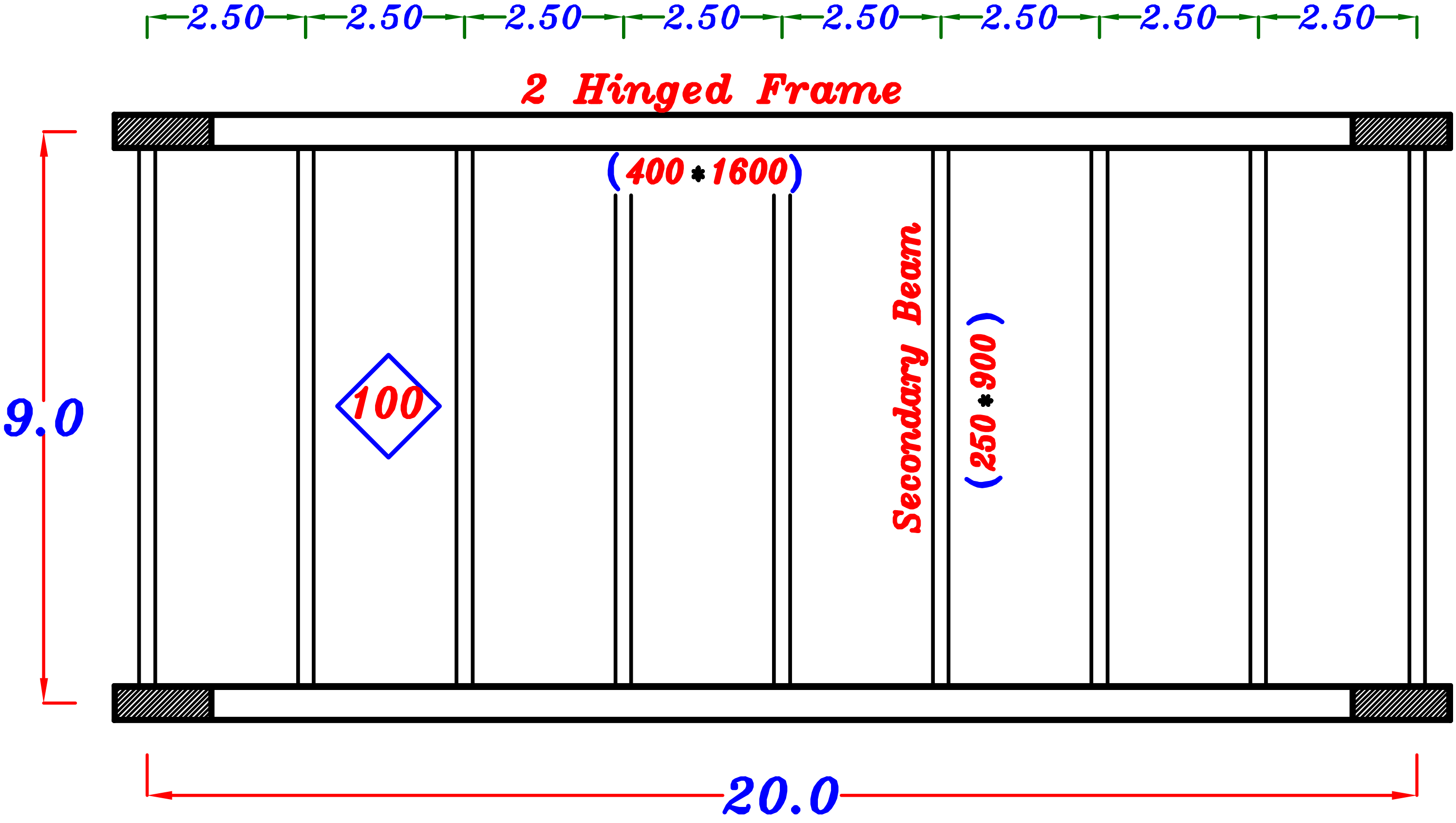
2 – Design the main supporting element.

3 – Draw details of RFT. For main supporting element in elevation to scale 1:50 and cross sections to scale 1:10

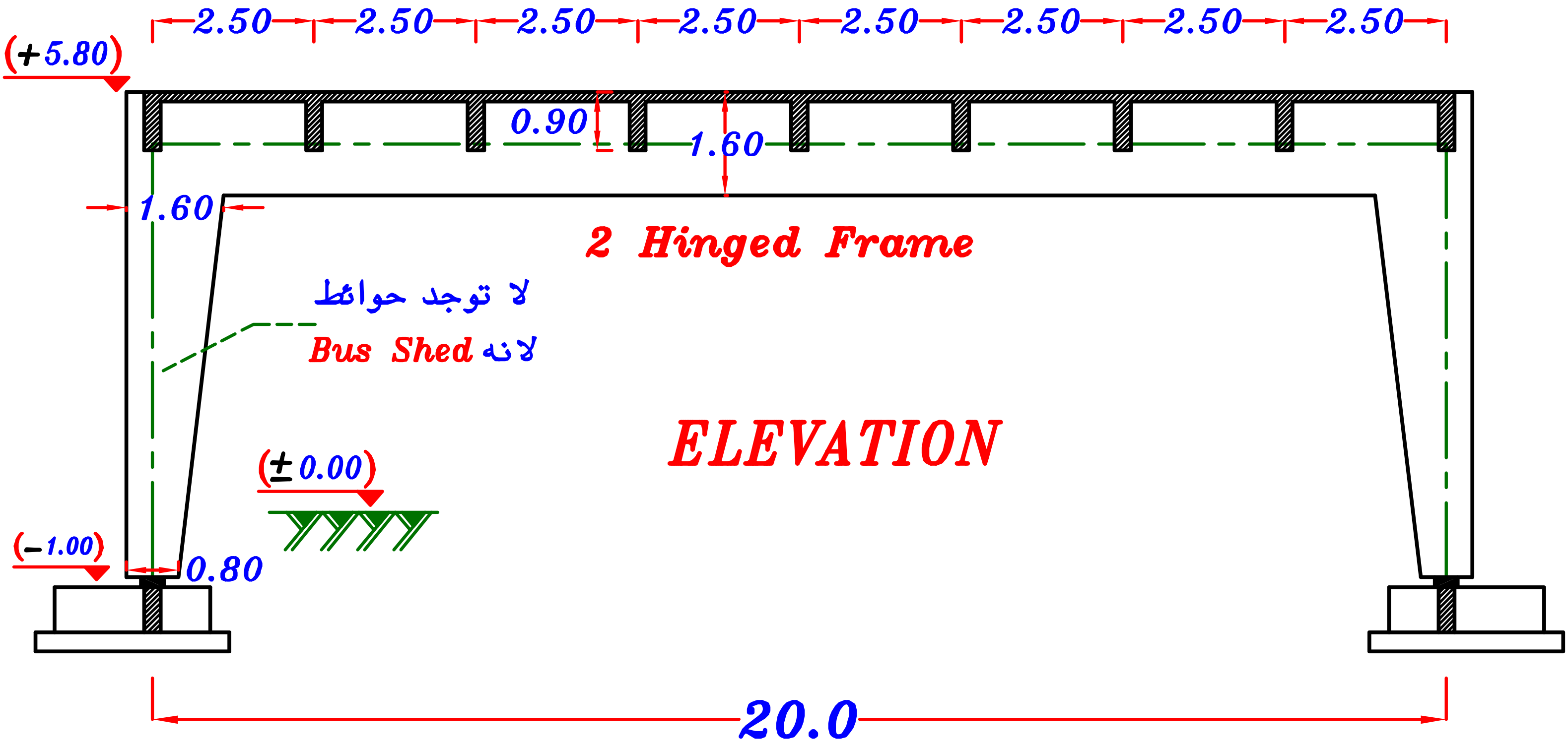
Figure (1)



1 – Draw plan and elevation showing the concrete dimensions of the slabs, beams and the main supporting elements.



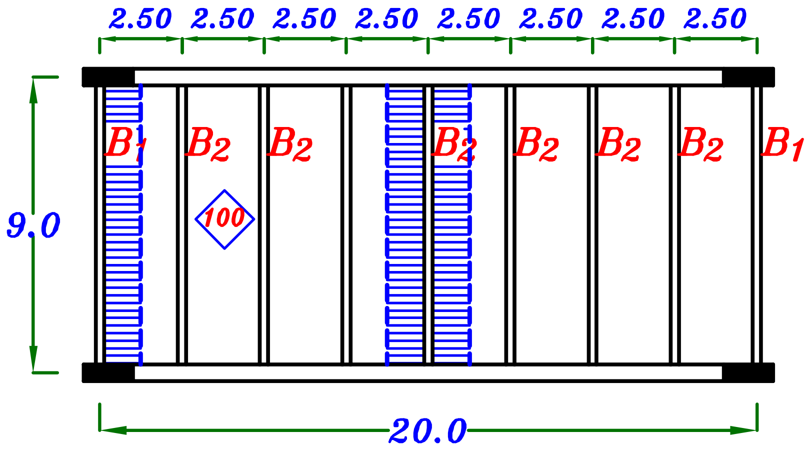
PLAN



ELEVATION

2 – Design the main supporting element.

Load Distribution.



$$t_s = \frac{2500}{30} = 83.33 \ mm$$

Take $\boxed{t_s = 100 \ mm}$

$$w_s = 1.5\,(0.10 * 25 + 3.0) = 8.25 \ kN\backslash m^2$$

$$o.w.(Beam) = 1.4\, b\, t\, \gamma_c = 1.4\,(0.25)(0.9)(25) = 7.90 \ kN\backslash m`$$

B_1

$$w_a = o.w. + w_s \frac{L_s}{2} = 7.90 + (8.25)\left(\frac{2.5}{2}\right) = 18.2 \ kN\backslash m`$$

$$R_1 = 18.2 * \frac{9.0}{2} = 84.9 \ kN \qquad \boxed{R_1 = 81.9 \ kN}$$

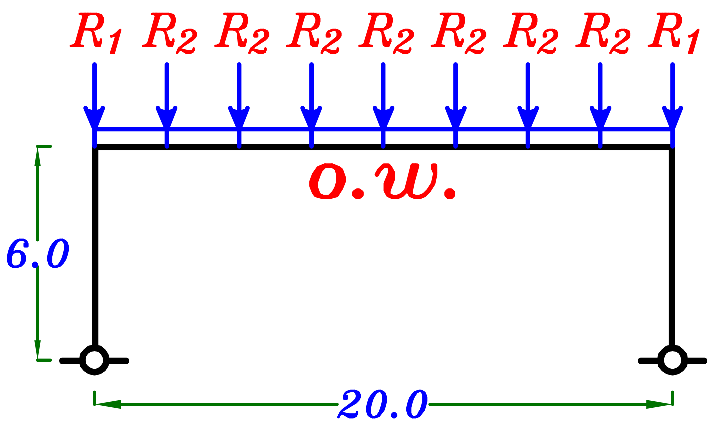
B_2

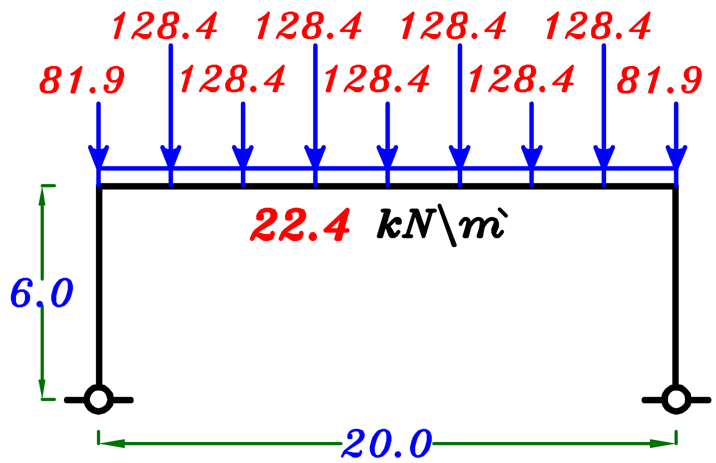
$$w_a = o.w. + 2\, w_s \frac{L_s}{2} = 7.90 + 2\,(8.25)\left(\frac{2.5}{2}\right) = 28.52 \ kN\backslash m`$$

$$R_2 = 28.52 * \frac{9.0}{2} = 128.4 \ kN \qquad \boxed{R_2 = 128.4 \ kN}$$

Loads on Frame.

$$o.w.(Beam) = 1.4\, b\, t\, \gamma_c = 1.4\,(0.40)(0.16)(25) = 22.4 \ kN\backslash m`$$

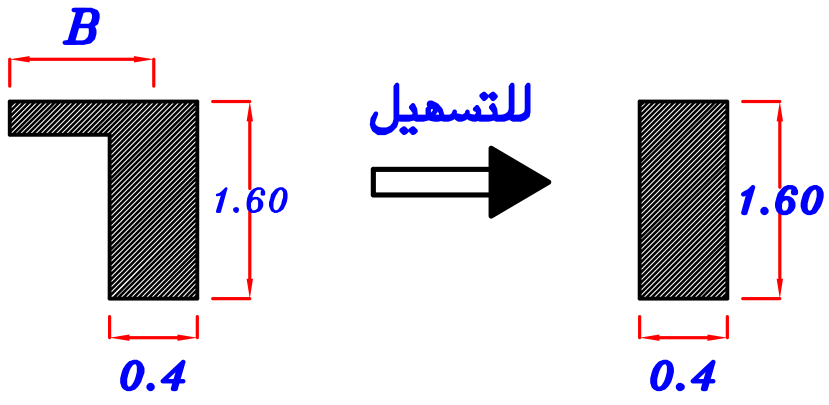




Using Moment Distribution.

$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12} = \frac{0.4\left(\frac{5}{6}*1.60\right)^3}{12} = 0.079\ m^4$$

$\underline{I_b}$



$$I_b = \frac{b\,t^3}{12} = \frac{0.4\,(1.60)^3}{12} = 0.136\ m^4$$

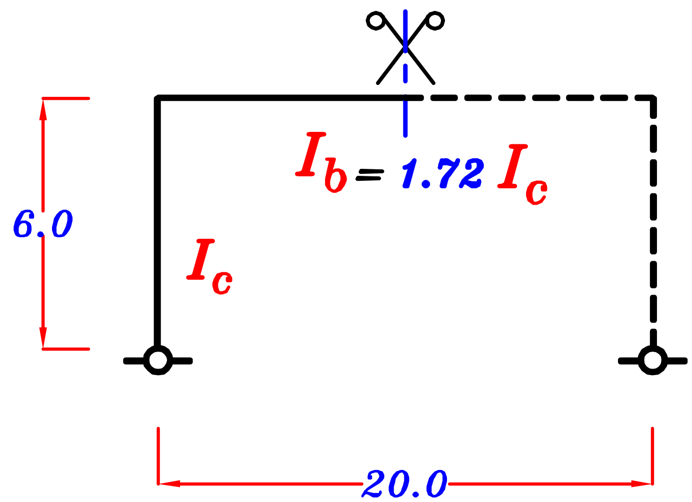
$$\boxed{I_b = 1.72\ I_c}$$

D.F.

$$K_c = \frac{3}{4}\frac{I_c}{h} = \frac{3}{4}*\frac{I_c}{6.0} = 0.125\ I_c$$

$$K_b = \frac{1}{2}\frac{I_b}{L} = \frac{1}{2}*\frac{(1.72)I_c}{20.0} = 0.043\ I_c$$

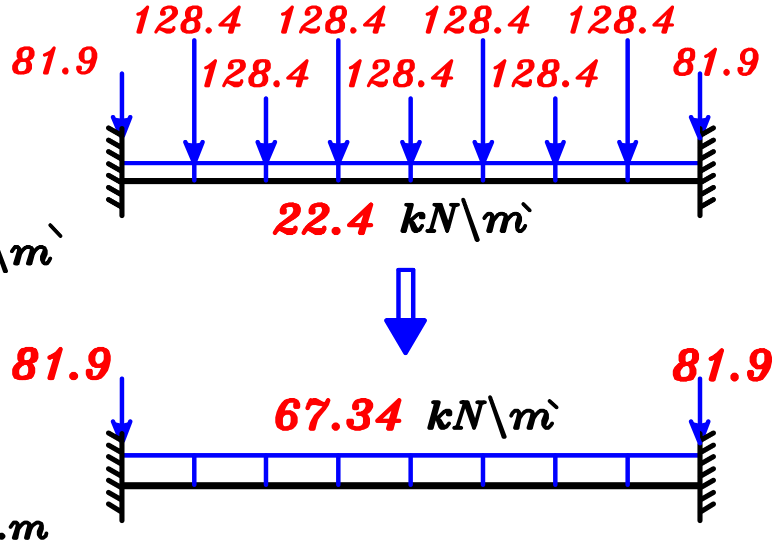
$$D.F._c = \frac{0.125}{0.125+0.043} = 0.744$$



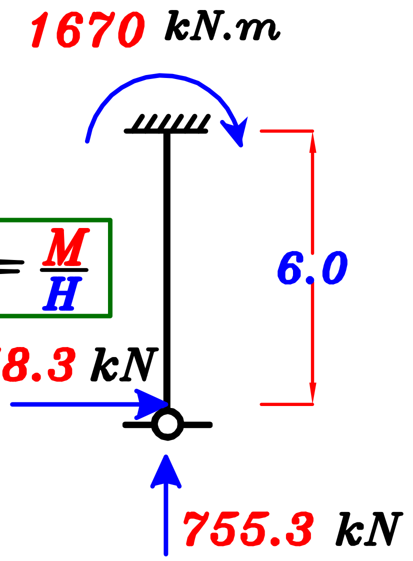
F.E.M.

$$w = o.w. + \frac{\Sigma P}{span}$$

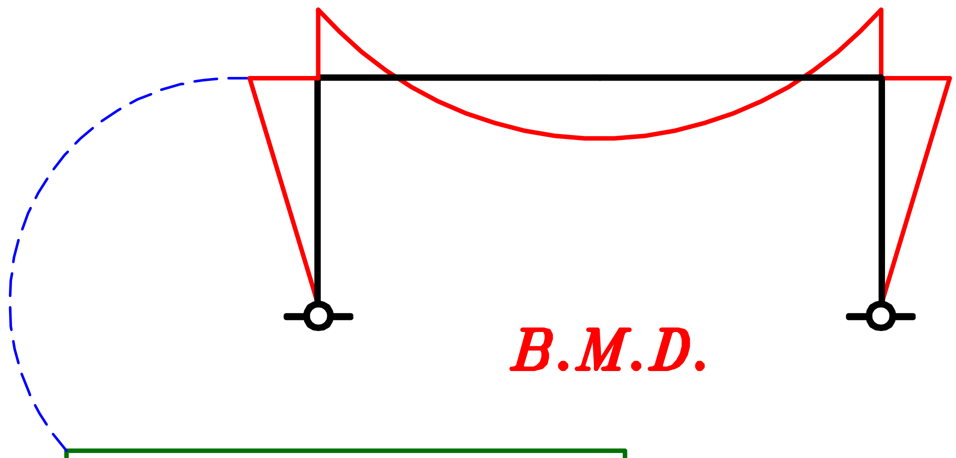
$$= 22.4 + \frac{7\,(128.4)}{20.0} = 67.34\ kN\backslash m`$$



$$F.E.M. = \frac{wL^2}{12} = \frac{67.34*(20.0)^2}{12} = 2244.6\ kN.m$$

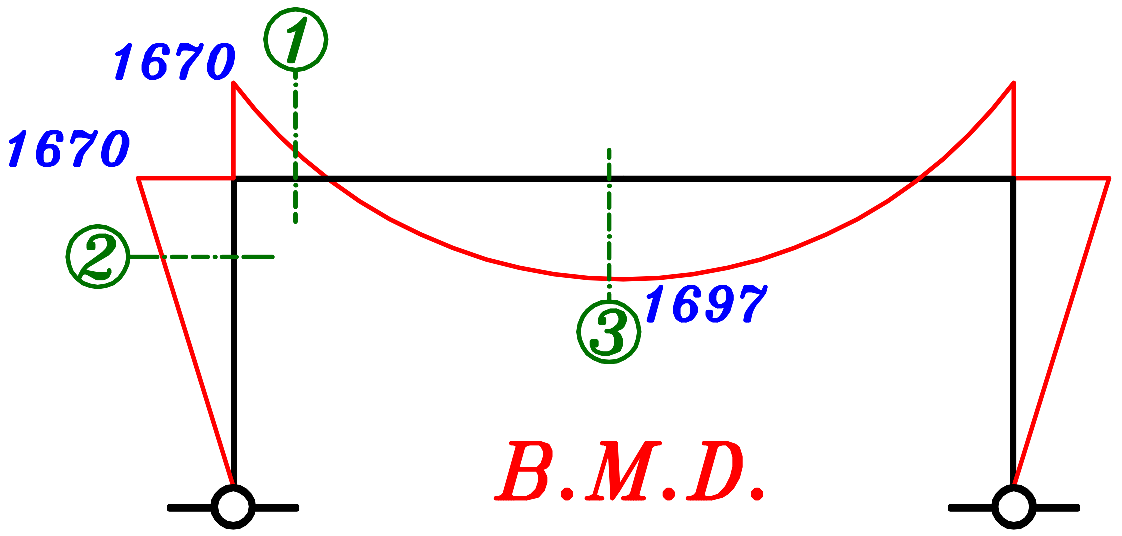


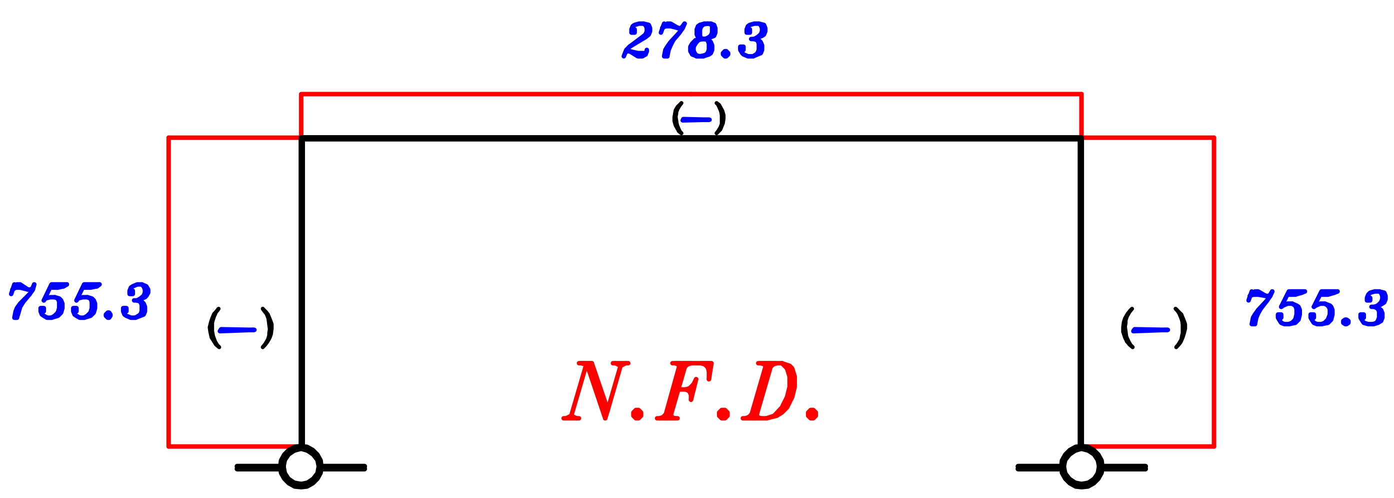
$$X = \frac{M}{H}$$



F.E.M. (Beam) * D.F. (Col.)

$$2244.6 * 0.744 = 1670$$





Design of Sections.

Sec. ① R–Sec.

$M = 1670$ kN.m , $P = 278.3$ kN , $b = 400$ mm , $t = 1600$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{278.3 * 10^3}{25 * 400 * 1600} = 0.017 < 0.04$ (neglect P)

$\therefore 1500 = C_1 \sqrt{\frac{1670 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.67 \longrightarrow J = 0.788$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1670 * 10^6}{0.788 * 400 * 1500} = 3532.1 \text{ mm}^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 3532.1 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 1500 = 1687.5 \text{ mm}^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 3532.1 \text{ mm}^2$ $\quad 8 \Phi 25$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{25 + 25} = 7.50 = 7.0 \text{ bars}$$

Sec. ② R–Sec. Neglect Effect of Buckling.

$M = 1670$ kN.m , $P = 755.3$ kN

Check $\frac{P}{F_{cu}\, b\, t} = \frac{755.3 * 10^3}{25 * 400 * 1600} = 0.0472 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{1670}{755.3} = 2.21$ m $\quad \therefore \frac{e}{t} = \frac{2.21}{1.60} = 1.37 > 0.5 \xrightarrow{use} e_s$

$$e_s = e + \frac{t}{2} - c = 2.21 + \frac{1.6}{2} - 0.1 = 2.91 \text{ m}$$

$$M_s = P * e_s = 755.3 * 2.91 = 2197.92 \text{ kN.m}$$

$$\therefore 1500 = C_1 \sqrt{\frac{2197.92 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.20 \longrightarrow J = 0.760$$

$$\therefore A_s = \frac{M_s}{J\,F_y\,d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{2197.92 * 10^6}{0.760 * 400 * 1500} - \frac{755.3 * 10^3}{(400 \backslash 1.15)}$$

$$= 2648.5 \ mm^2$$

<u>Check $A_{s\,min.}$</u> $\quad A_{s_{req.}} = 2648.5 \ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 1500 = 1687.5 \ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 2648.5 \ mm^2$ $\quad$ $6 \Phi 25$

<u>Sec. ③</u> L−Sec.

$M = 1697 \ kN.m$, $P = 278.3 \ kN$, $b = 400 \ mm$, $t = 1600 \ mm$

Check $\quad \dfrac{P}{F_{cu}\, b\, t} = \dfrac{278.3 * 10^3}{25 * 400 * 1600} = 0.017 < 0.04$ (neglect P)

$$B = \begin{cases} C.L. - C.L. = 4.50 \ m = 4500 \ mm \\ 6\, t_s + b = 6 * 100 + 400 = 1000 \ mm \\ K \dfrac{L}{10} + b = 0.7 * \dfrac{20000}{10} + 400 = 1800 \ mm \end{cases}$$

$$\boxed{B = 1000 \ mm}$$

$$\therefore 1500 = C_1 \sqrt{\frac{1697 * 10^6}{25 * 1000}} \longrightarrow C_1 = 5.75 \longrightarrow J = 0.826$$

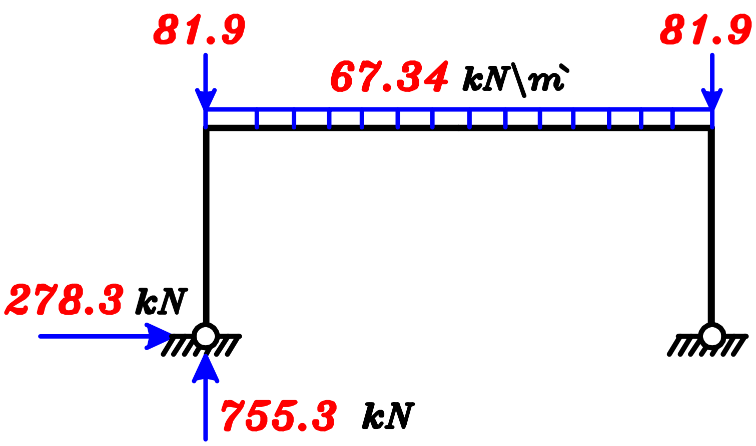
$$\therefore A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{1697 * 10^6}{0.826 * 400 * 1500} = 3424.1 \ mm^2$$

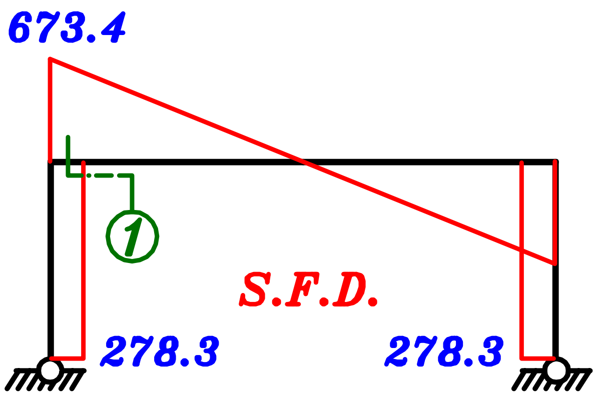
<u>Check $A_{s\,min.}$</u> $\quad A_{s_{req.}} = 3424.1 \ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 1500 = 1687.5 \ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 3424.1 \ mm^2$ $\quad$ $7 \Phi 25$

Check Shear.





Sec. 1

$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \quad N\backslash mm^2$$

$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \quad N\backslash mm^2$$

$$q_u = \frac{Q_{max}}{b\ d} = \frac{673.4 * 10^3}{400 * 1500} = 1.12 \ N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\therefore$ We need Stirrups more Than $5\phi 8\backslash m`$

$\therefore$ Use $$q_S = q_u - \frac{q_{cu}}{2} = \frac{n A_s (F_y \backslash \gamma_s)}{b\ \ S}$$

$*$ Take $n = 2$, $\phi\ 8 \longrightarrow A_s = 50.3\ mm^2$

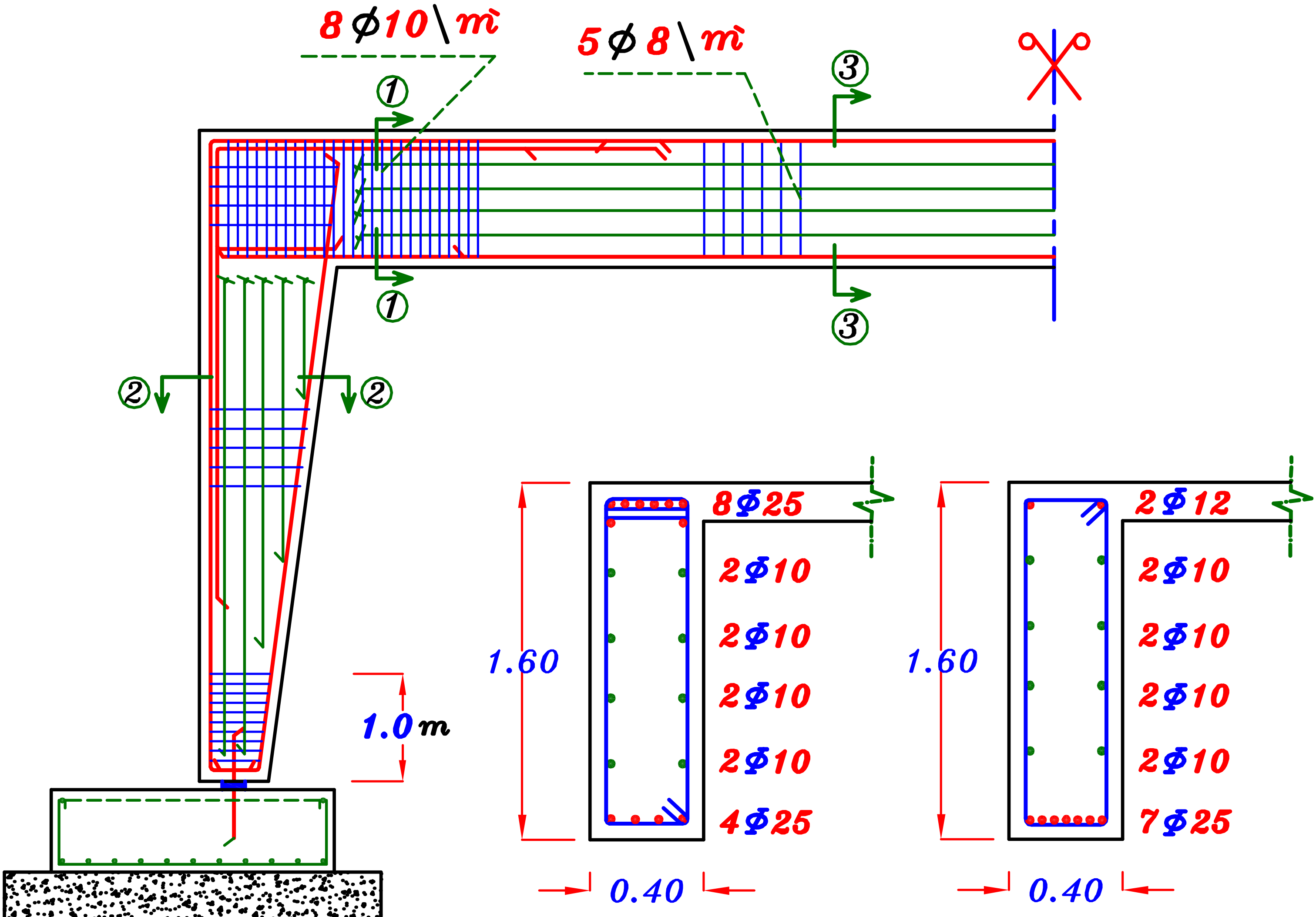
$$1.12 - \frac{0.98}{2} = \frac{2 * 50.3\ (240 \backslash 1.15)}{400 * S} \longrightarrow S = 83.3\ mm < 100\ mm$$

$*$ Take $n = 2$, $\phi\ 10 \longrightarrow A_s = 78.5\ mm^2$

$$1.12 - \frac{0.98}{2} = \frac{2 * 78.5\ (240 \backslash 1.15)}{400 * S} \longrightarrow S = 130.0\ mm > 100\ mm \therefore o.k.$$

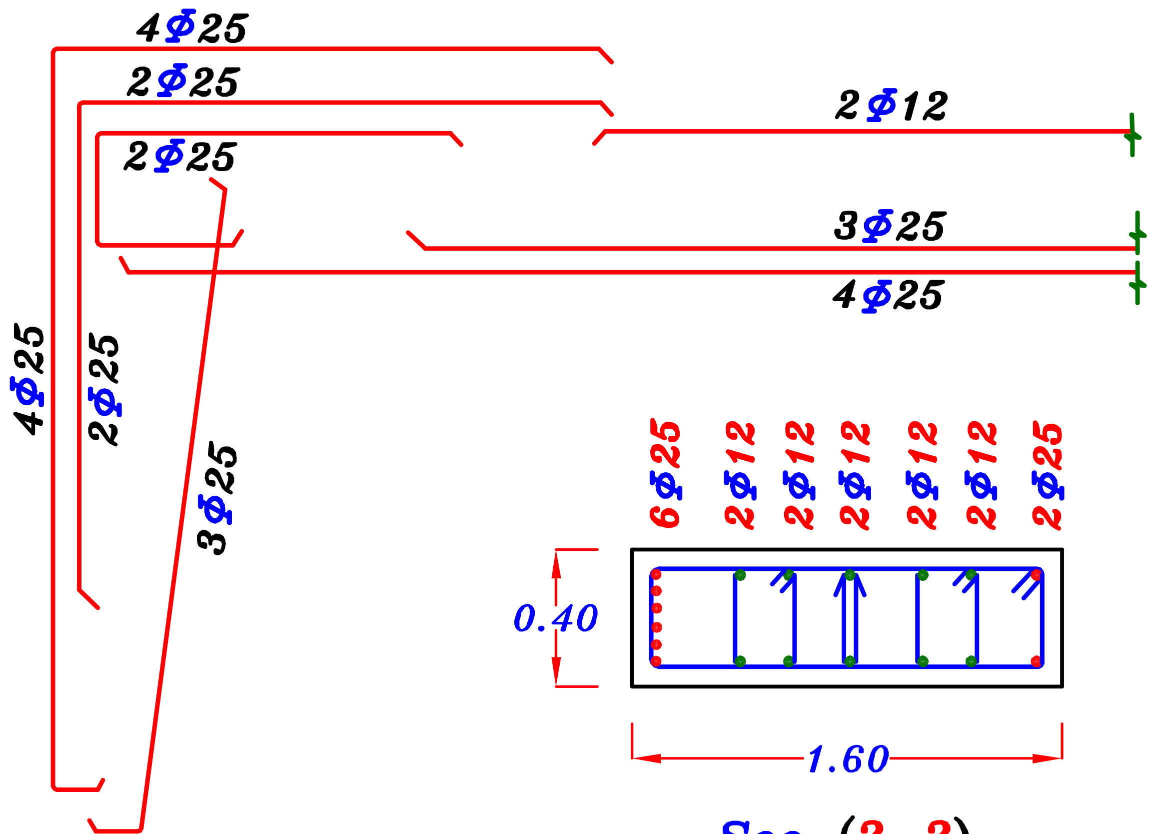
$\therefore$ No. of stirrups$\backslash m`$ $= \frac{1000}{S} = \frac{1000}{130.0} = 7.69 = 8\ \backslash m`$

$\therefore$ Use Stirrups $\boxed{8\phi 10\backslash m`}$ 2 branches



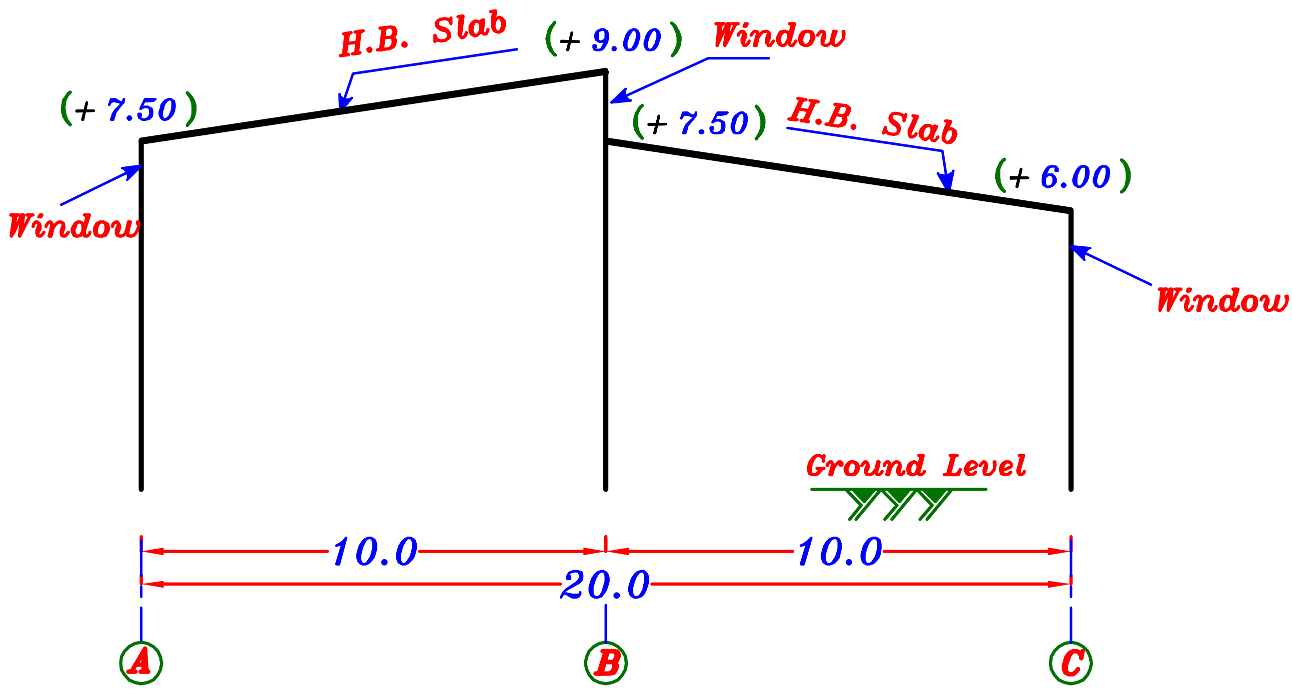
Sec. (1–1)

Sec. (3–3)



Sec. (2–2)

Example.



The Figure shows the cross sectional elevation of a R.C. Factory with dimensions 20.0 × 20.0 meters. Columns are allowed on axes A , B & C as shown and spaced every 5.0 m . Covering slabs are one way Hollow-Block Slab of 5.0 m span supported on the main supporting elements of the Factory.

$F_{cu} = 25 \ N\backslash mm^2$, $F_y = 360 \ N\backslash mm^2$

Question 1 :

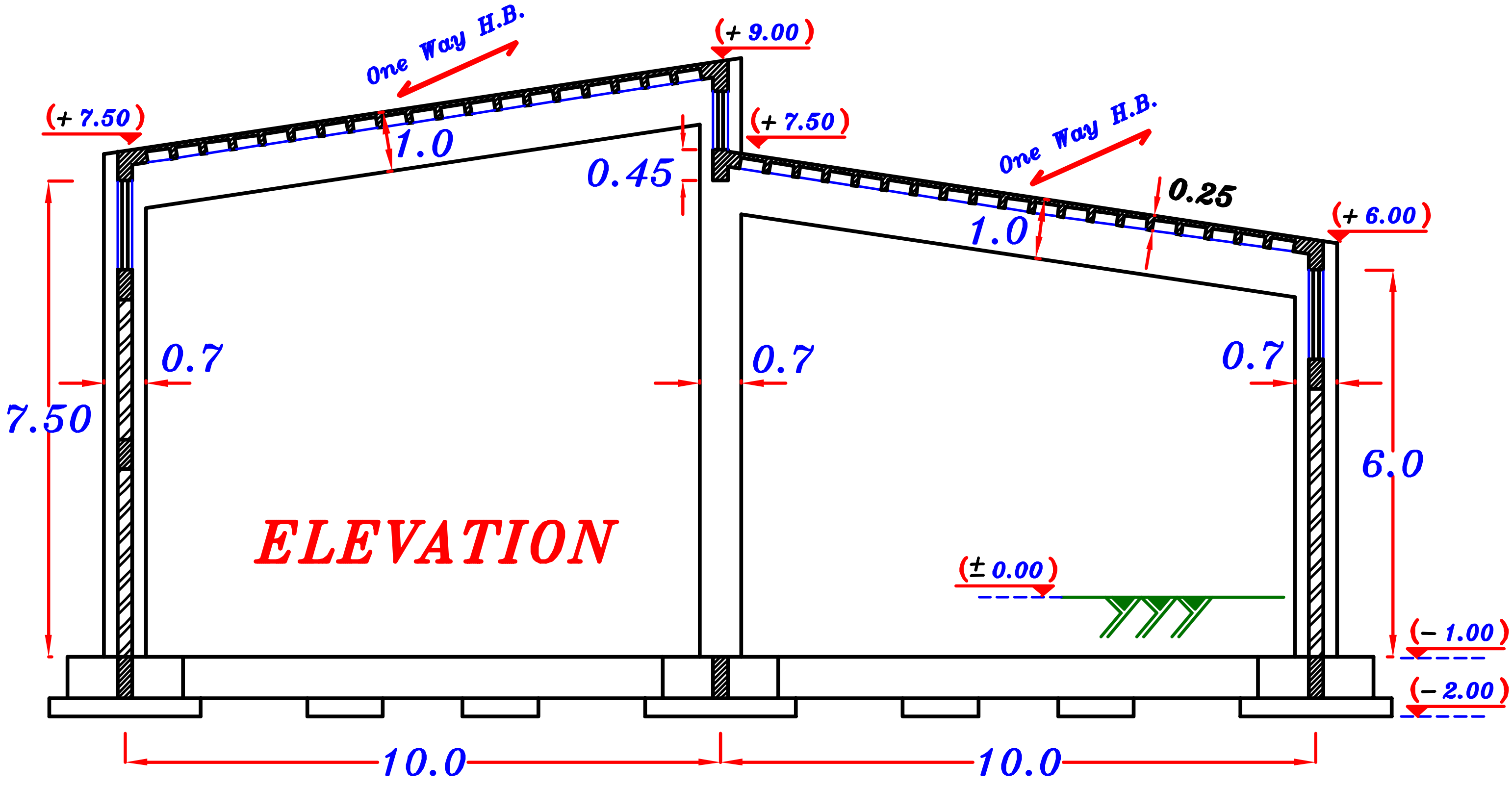
Without any calculations but with reasonably concrete dimensions draw to scale 1:50 in elevation and part plan concrete dimensions of the main supporting elements of the Factory including columns & Foundations and show the arrangement of Hollow Blocks.

Question 2 :

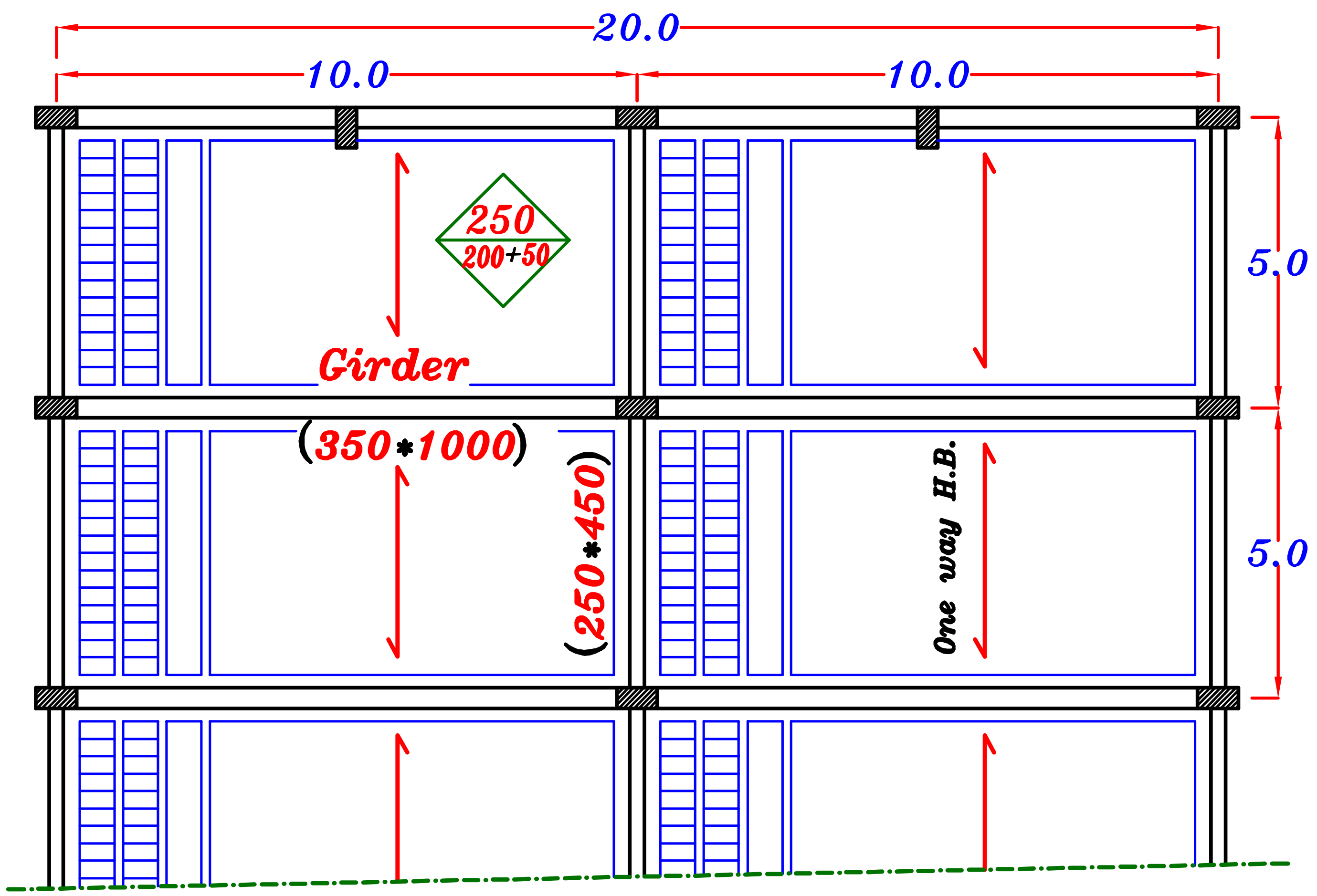
IF no internal columns are allowed in the Factory.
i.e. only columns at axes A & C

1- Without any calculation but with reasonably assumed concrete dimensions, draw to scale 1:50 in elevation only concrete dimensions of the main supporting element including Foundations.
2- Carry out load distribution and calculate the loads on the main element.
3- Design all sections of the main element.
4- Draw to scale 1:50 details of reinforcement of the main supporting element in elevation and draw the necessary cross sections to scale 1:10
5- IF the slab at levels 7.50 & 9.00 become at levels 9.00 & 10.50 Draw a new concrete dimensions in elevation.

1



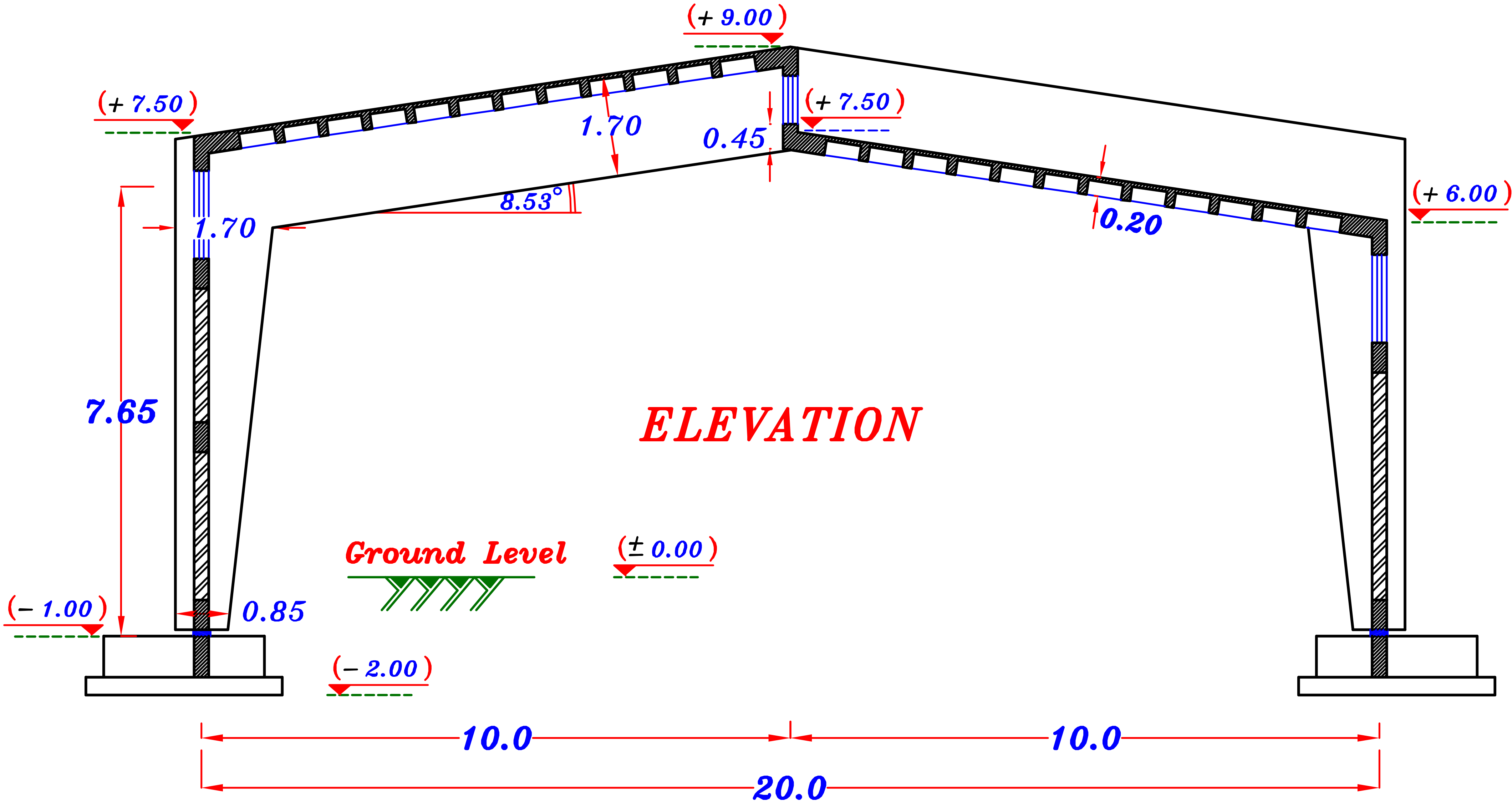
One Way H.B.
(+ 9.00)
(+ 7.50)
(+ 7.50)
One Way H.B.
1.0
0.45
0.25
1.0
(+ 6.00)
7.50
0.7
0.7
0.7
6.0
ELEVATION
(± 0.00)
(− 1.00)
(− 2.00)
10.0
10.0



20.0
10.0
10.0
250
200+50
5.0
Girder
(350*1000)
(250*450)
One way H.B.
5.0

PLAN

② ① Use Two Hinged Inclined Frame



② ② Loads From Slabs. (Using one way H.B. slab at 5.0 m)

∵ The Roof is inclined Take F.C. $= 0.50\ kN\backslash m^2$, L.L. $= 0.50\ kN\backslash m^2$

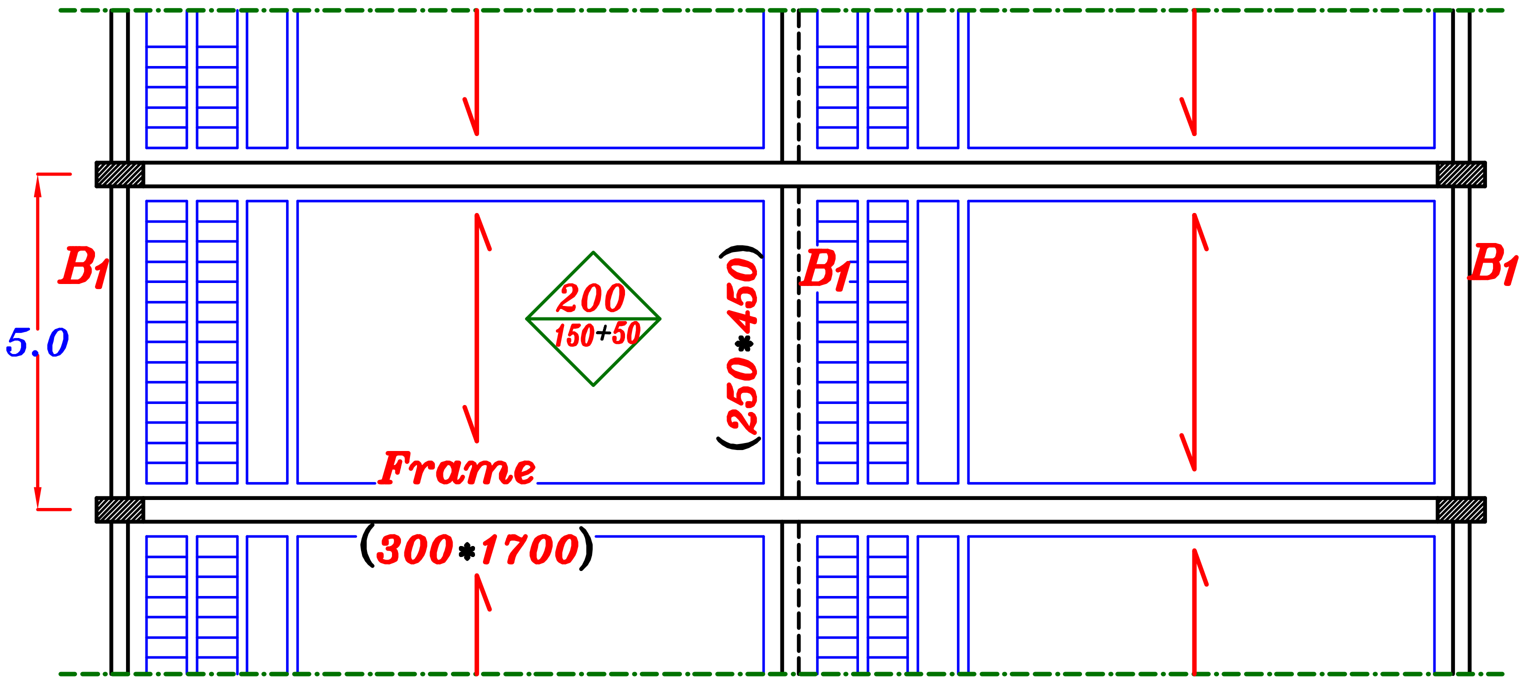
$$t = \frac{5000}{25} = 200\ mm$$

$\boxed{t = 200\ mm}$ $\boxed{t_s = 50\ mm}$ $\boxed{h = 150\ mm}$

Weight of Block $= 100\ N$, $S = e + b = 0.4 + 0.1 = 0.5\ m$

$$\boxed{w_{rib\,i} = \left[1.4\,(t_s \gamma_c + F.C.) + 1.6\,(L.L.)\,Cos\,\theta\right](S * 1.0) + 1.4\,(b\,h * 1.0\,m * \gamma_c) + 1.4 * (\text{Block وزن ال})\left(\frac{1.0}{a}\right)}$$

$$\therefore w_{rib\,i} = \left[1.4\,(0.05 * 25 + 0.5) + 1.6\,(0.5)\,Cos\,8.53^\circ\right](0.50 * 1.0) + 1.4\,(0.10 * 0.15 * 1.0 * 25) + 1.4\left(\frac{100}{1000}\right)\left(\frac{1.0}{0.2}\right) = 2.84$$



Loads on Beam B_1

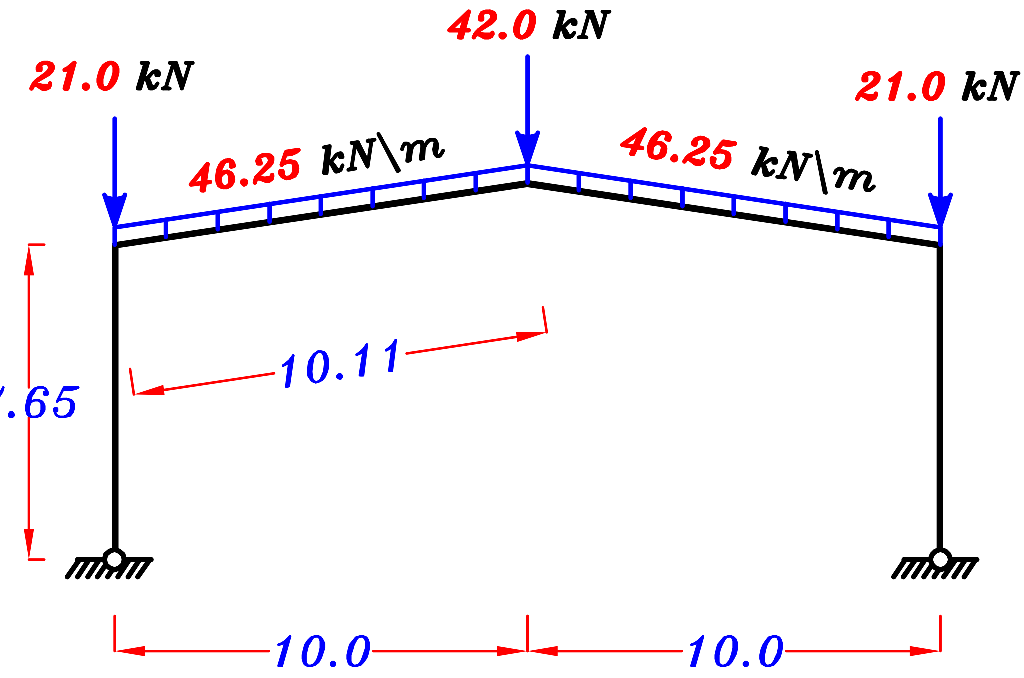
$w = o.w. = 1.4 * 3.0 = 4.20\ kN\backslash m$

$R_1 = w * S = 4.20 * 5.0 = 21.0\ kN$

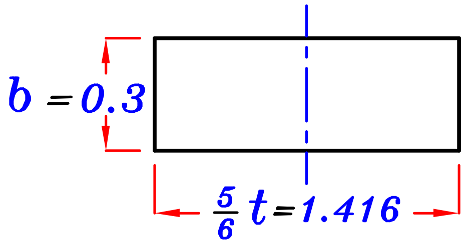
Loads on Frame F

$o.w.(Frame) = 1.4\,(0.30 * 1.70 * 25) = 17.85\ kN\backslash m$

$$w = o.w. + \frac{w_{rib}}{S} * L_s = 17.85 + \frac{2.84}{0.5} * 5.0 = 46.25\ kN\backslash m$$



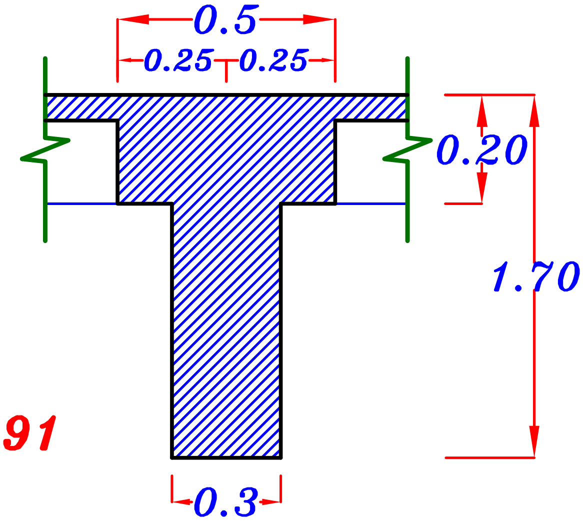
$\underline{\underline{I_c}}$



$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12} = \frac{0.3\left(\frac{5}{6} * 1.70\right)^3}{12}$$

$$= 0.071 \ m^4$$

$\underline{\underline{I_b}}$



$$I_1 = (\mu * 10^{-4}) \ B \, t^3$$

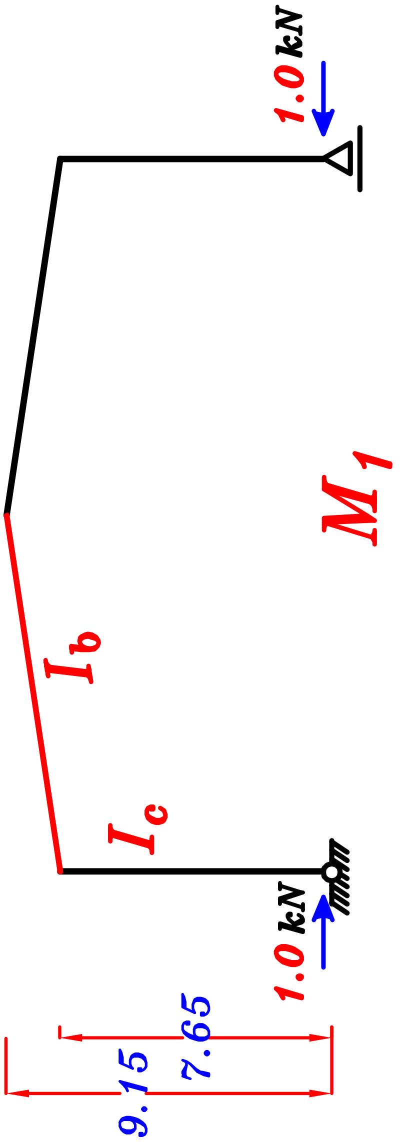
$b = 0.30 \ m$, $t_s = 0.20 \ m$

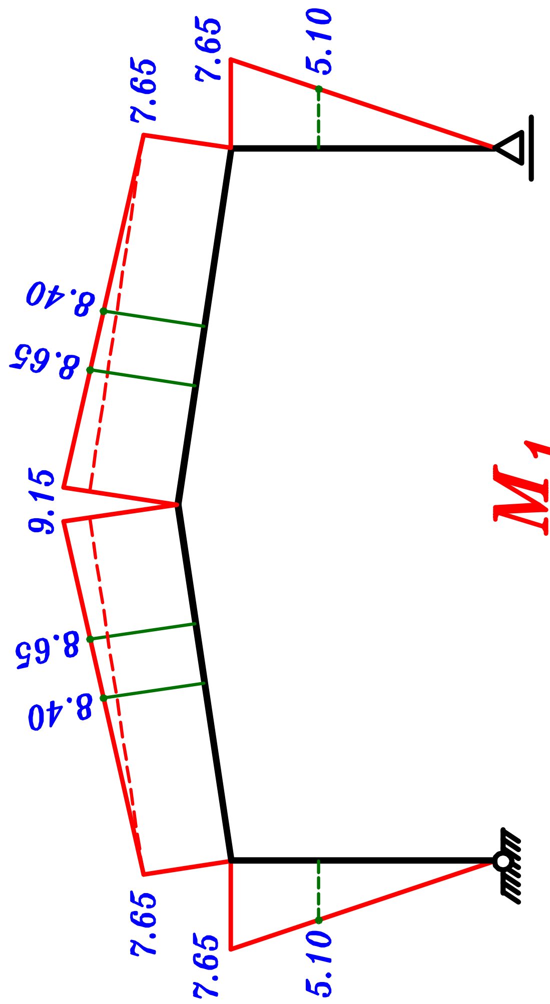
$B = 0.50 \ m$, $t = 1.70 \ m$

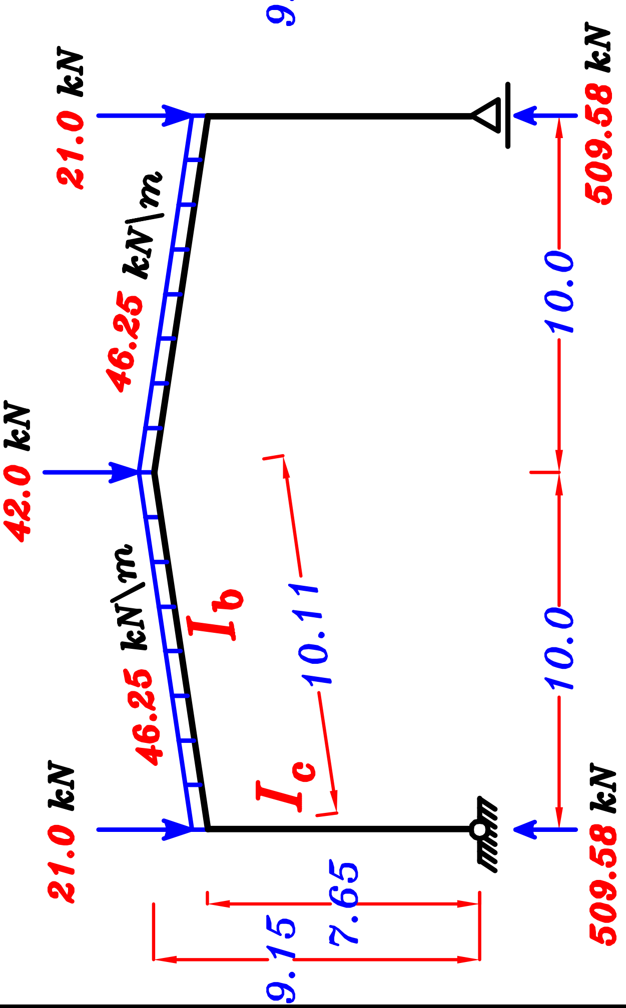
$$\left.\begin{aligned} \frac{t_s}{t} &= \frac{0.20}{1.70} = 0.117 \\ \frac{b}{B} &= \frac{0.30}{0.50} = 0.60 \end{aligned}\right\} \text{From Tables page } 91 \quad \mu = 606$$

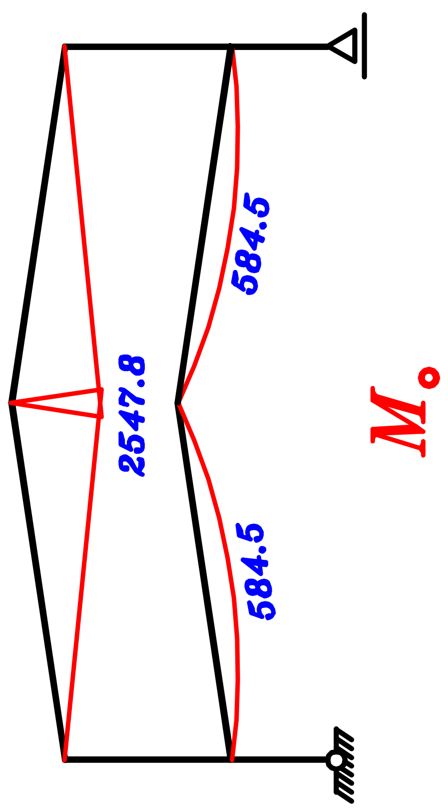
$$I_b = (\mu * 10^{-4}) \ B \, t^3 = (606 * 10^{-4} * 0.50 * 1.70^3) = 0.149 \ m^4$$

$$\therefore \quad \boxed{I_b = 2.10 \ I_c}$$


1.0 kN
I_b
I_c
M_1
1.0 kN
9.15
7.65


7.65
7.65
5.10
8.40
8.65
9.15
8.65
8.40
7.65
7.65
5.10
M_1


21.0 kN
46.25 kN\m
42.0 kN
46.25 kN\m
21.0 kN
I_b
I_c
10.11
10.0
10.0
509.58 kN
509.58 kN
9.15
7.65


2547.8
584.5
584.5
M_o

$$\delta_{1o} = \frac{1}{E_c\, I_c} * (M_o * M_1) + \frac{1}{E_c\, I_b} * (M_o * M_1)$$

$$\delta_{1o} = zero + \frac{2}{E_c\,(2.10)\, I_c}\left(-\tfrac{1}{2}(10.11)(2547.8)[8.65] - \tfrac{2}{3}(584.5)(10.11)[8.40]\right)$$

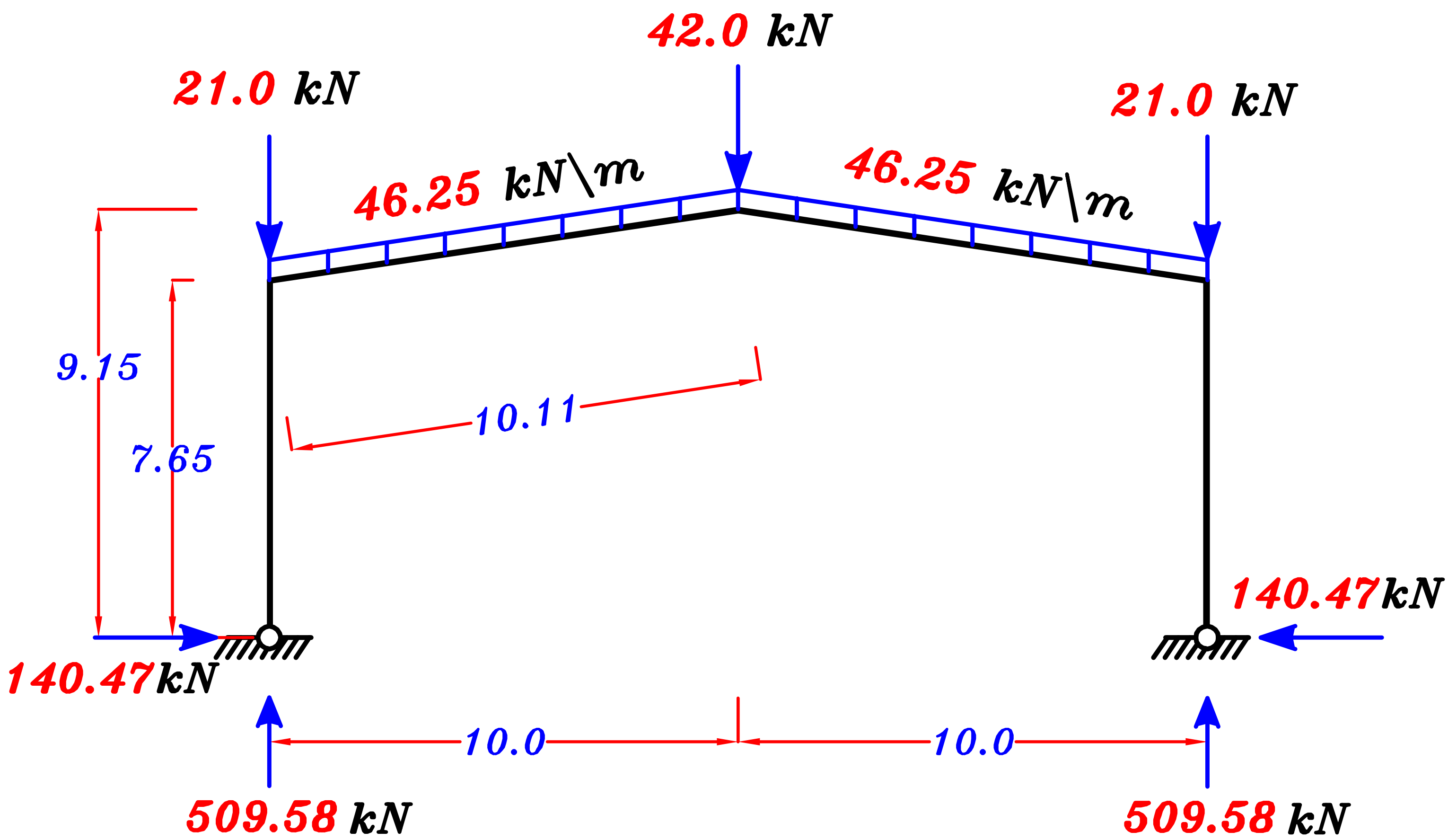
$$= \frac{-137615.73}{E_c\, I_c}$$

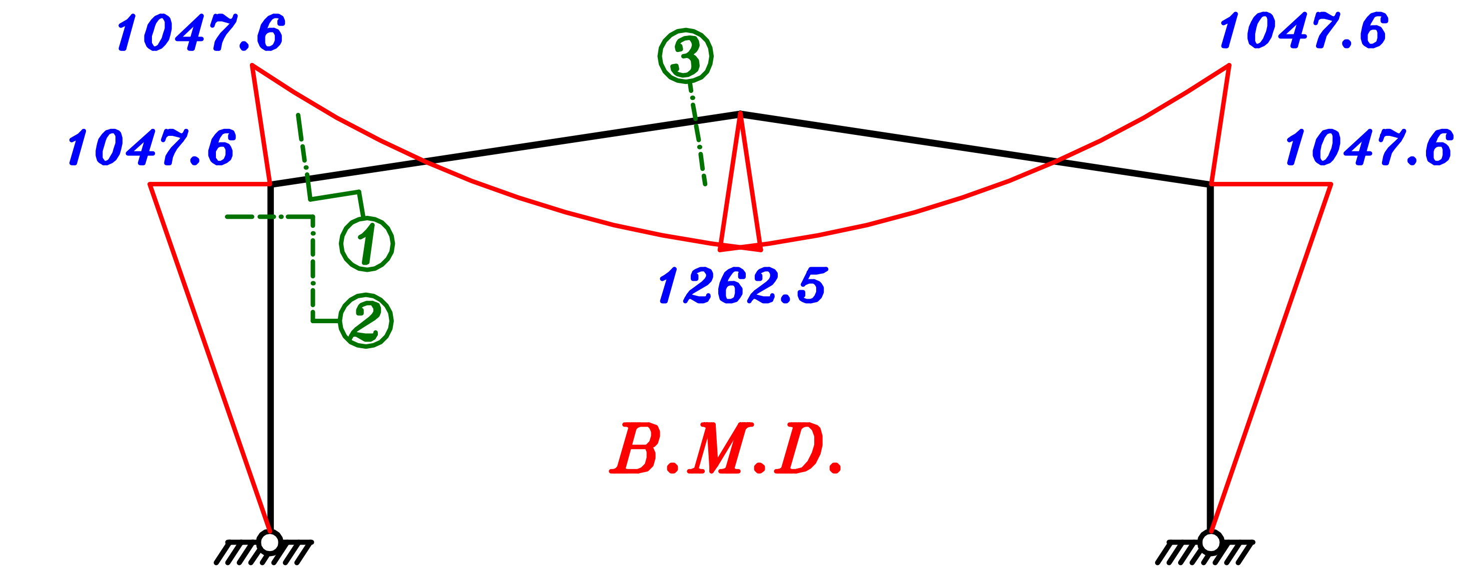
$$\delta_{11} = \frac{1}{E_c\, I_c} * (M_1 * M_1) + \frac{1}{E_c\, I_b} * (M_1 * M_1) = \frac{2}{E_c\, I_c}\left(\tfrac{1}{2}(7.75)(7.75)[5.16]\right)$$

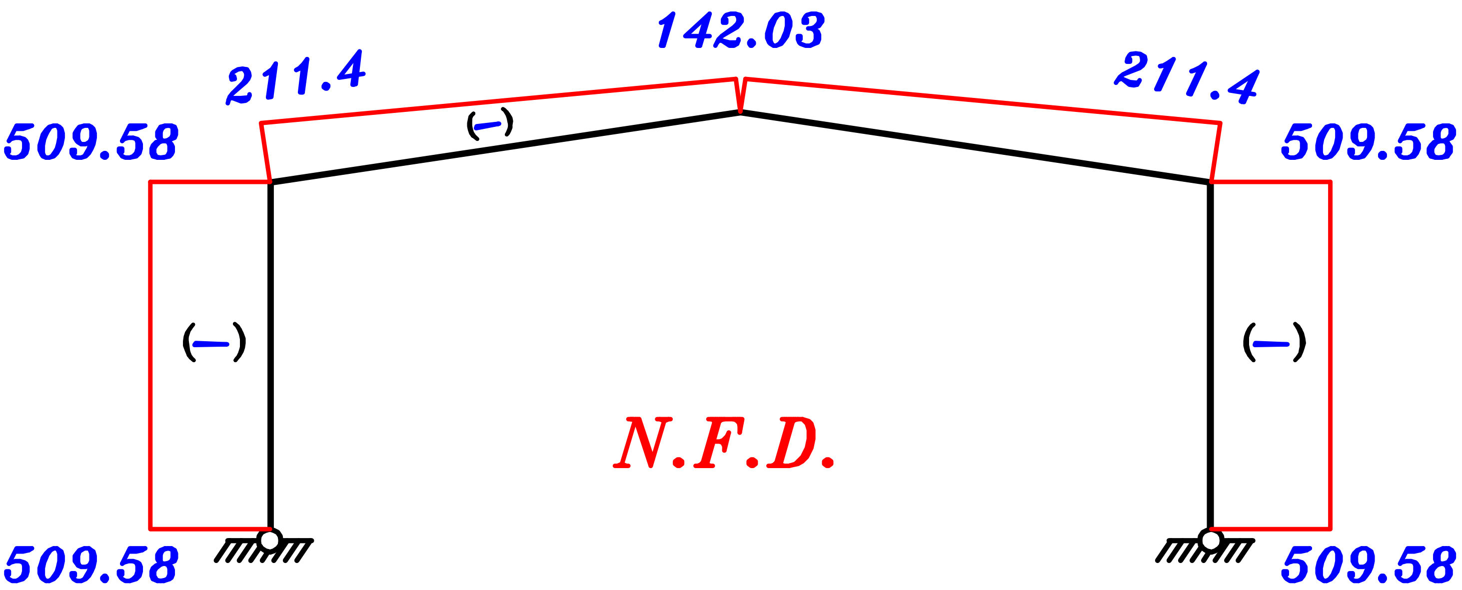
$$+ \frac{2}{E_c\,(2.10)\, I_c}\left((7.65)(10.11)[8.40] + \tfrac{1}{2}(10.11)(1.50)[8.65]\right) = \frac{979.66}{E_c\, I_c}$$

$$\because \quad \delta_{1o} + X\, \delta_{11} = Zero$$

$$\therefore \quad \frac{-137615.73}{E_c\, I_c} + X * \frac{979.66}{E_c\, I_c} = Zero \longrightarrow \boxed{X = 140.47\, kN}$$







Design of Sections.

Sec. ① R−Sec.

$M = 1047.6$ kN.m , $P = 211.4$ kN , $b = 300$ mm , $t = 1700$ mm

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{211.4 * 10^3}{25 * 300 * 1700} = 0.0166 < 0.04$ (neglect P)

$\therefore 1600 = C_1 \sqrt{\dfrac{1047.6 * 10^6}{25 * 300}} \longrightarrow C_1 = 4.23 \longrightarrow J = 0.812$

$\therefore A_S = \dfrac{M_{U.L.}}{J\, F_y\, d} = \dfrac{1047.6 * 10^6}{0.812 * 360 * 1600} = 2297.57$ mm^2

Check $A_{s\,min.}$ $A_{s_{req.}} = 2297.57\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1600 = 1500\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b\ d \quad \therefore$ Take $A_s = A_{s_{req.}} = 2297.57\ mm^2$ $\quad 7\phi 22$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{22 + 25} = 5.85 = 5.0 \text{ bars}$$

Sec. ② R−Sec.

Neglect Effect of buckling

$M = 1047.6\ kN.m$, $P = 509.58\ kN$, $b = 300\ mm$, $t = 1700\ mm$

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{509.58 * 10^3}{25 * 300 * 1700} = 0.039 < 0.04$ (Neglect P)

$$\therefore 1600 = C_1 \sqrt{\frac{1047.6 * 10^6}{25 * 300}} \longrightarrow C_1 = 4.23 \longrightarrow J = 0.812$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1047.6 * 10^6}{0.815 * 360 * 1600} = 2297.57\ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 2297.57\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1600 = 1500\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b\ d \quad \therefore$ Take $A_s = A_{s_{req.}} = 2297.57\ mm^2$ $\quad 7\phi 22$

Sec. ③ R−Sec. (Because the slab is H.B.)

$M = 1262.5$ kN.m , $P = 142.03$ kN , $b = 300$ mm , $t = 1700$ mm

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{142.03 * 10^3}{25 * 300 * 1700} = 0.011 < 0.04$ (neglect P)

$$\therefore 1600 = C_1 \sqrt{\frac{1262.5 * 10^6}{25 * 300}} \longrightarrow C_1 = 3.90 \longrightarrow J = 0.80$$

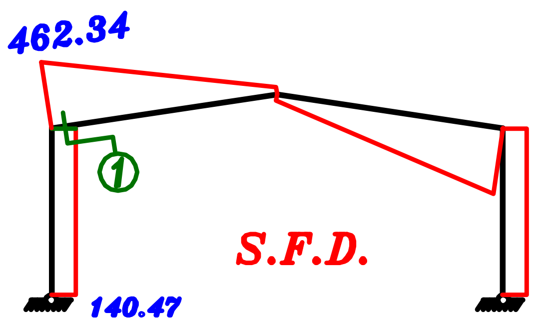
$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1338.9 * 10^6}{0.80 * 360 * 1600} = 2739.8 \text{ mm}^2$$

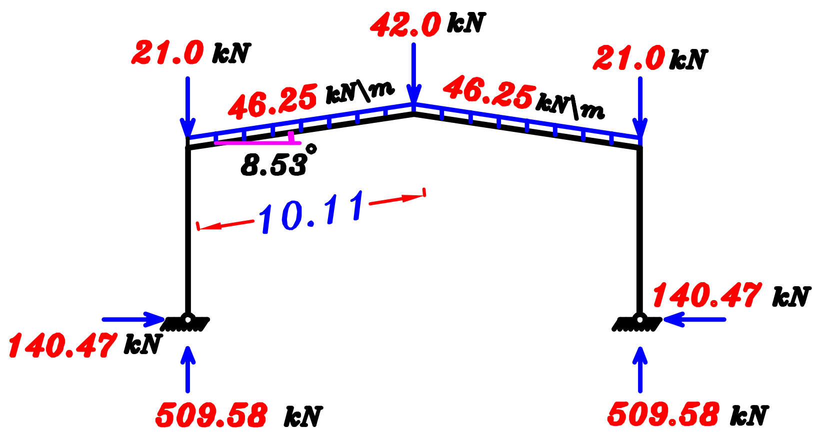
Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 2739.8 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 1600 = 1500 \text{ mm}^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 2739.8$ mm^2 $\quad 8 \phi 22$

Check Shear.



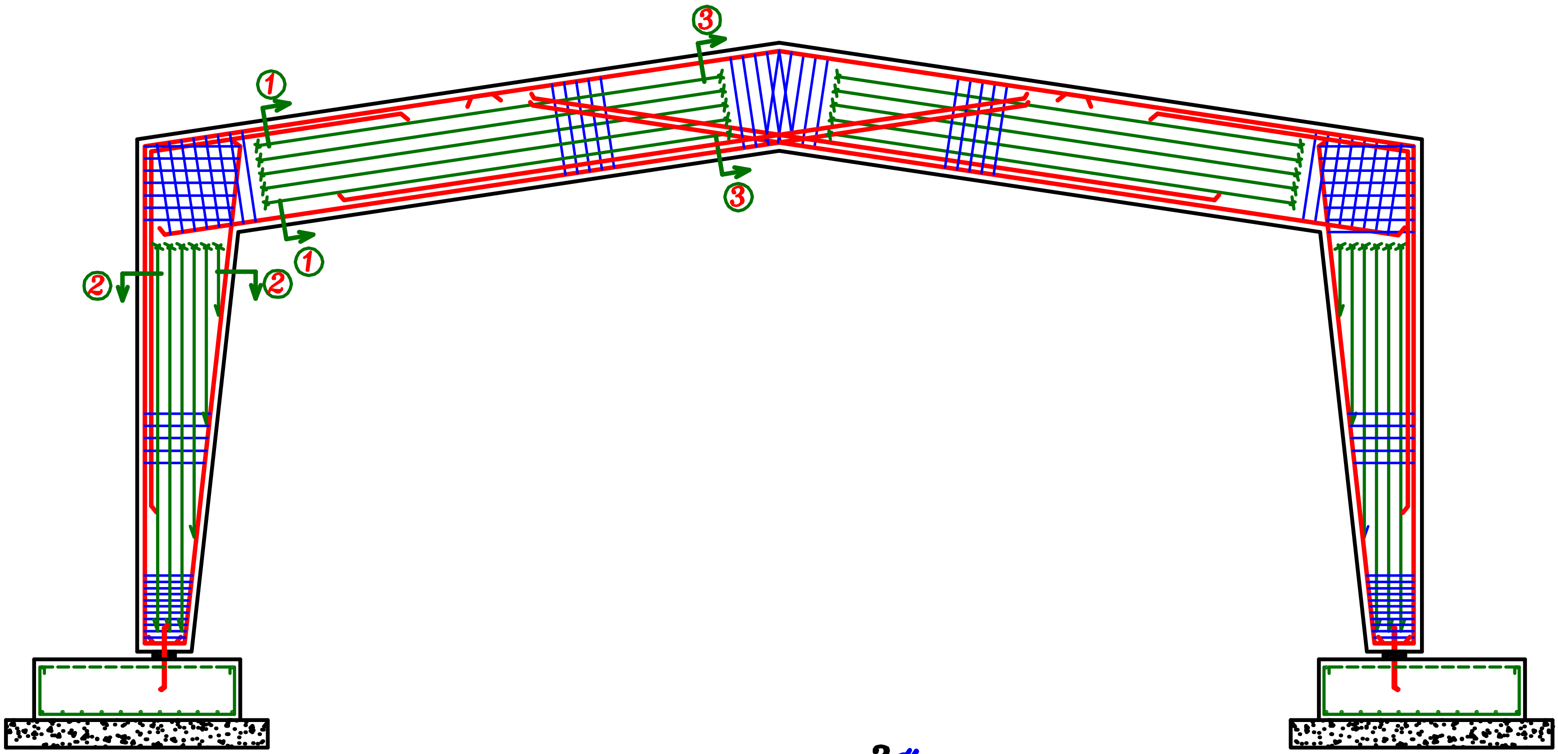


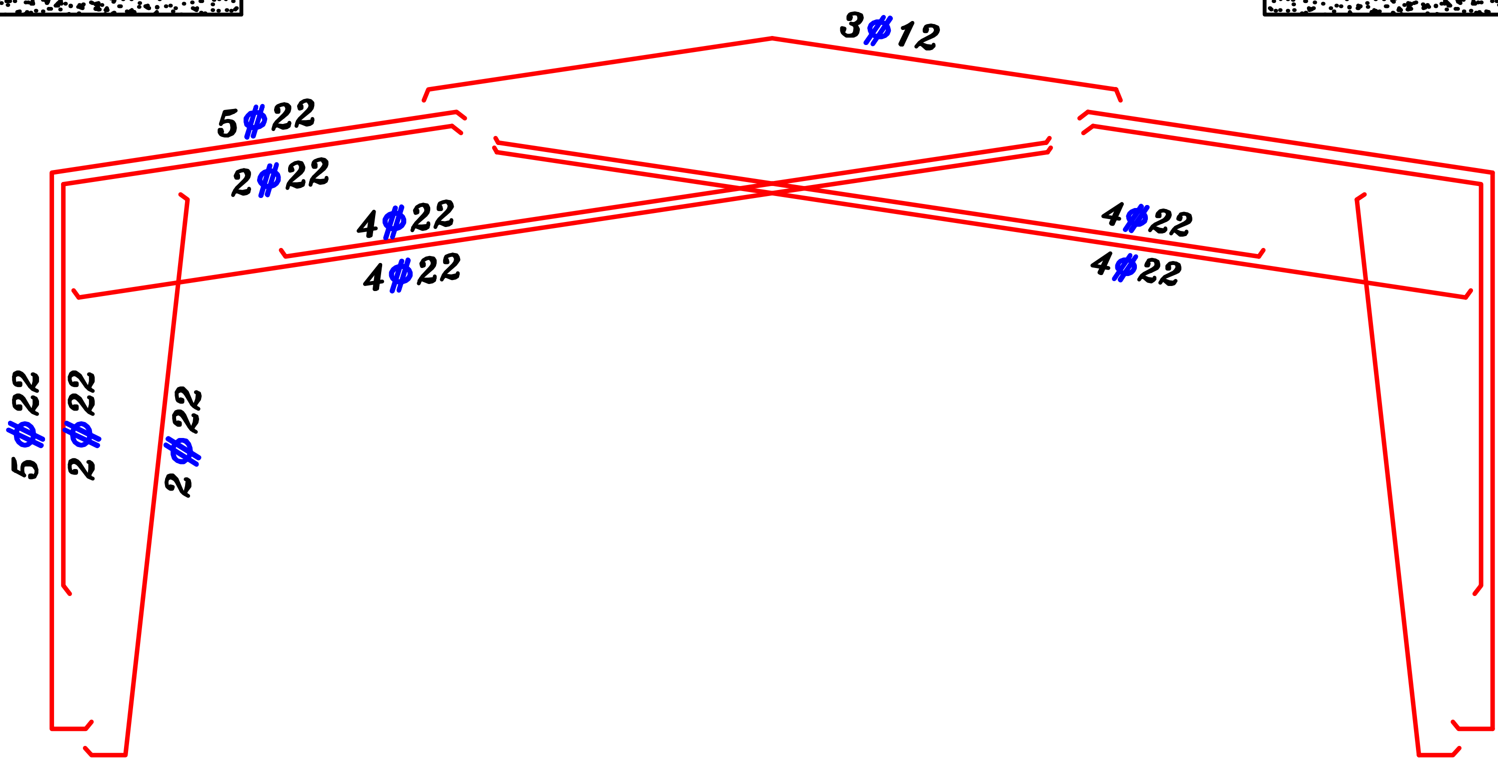
$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \text{ N\textbackslash mm}^2$$

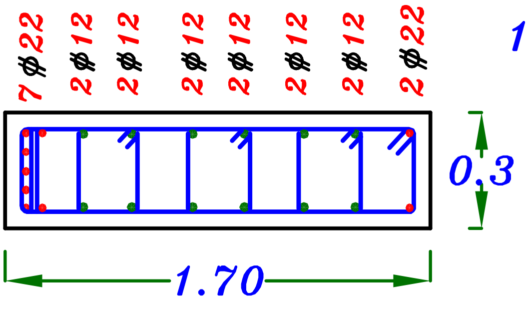
$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \text{ N\textbackslash mm}^2$$

Sec. ① $\quad q_u = \dfrac{Q_{max}}{b\, d} = \dfrac{462.34 * 10^3}{300 * 1600} = 0.963 \text{ N\textbackslash mm}^2 < q_{cu}$

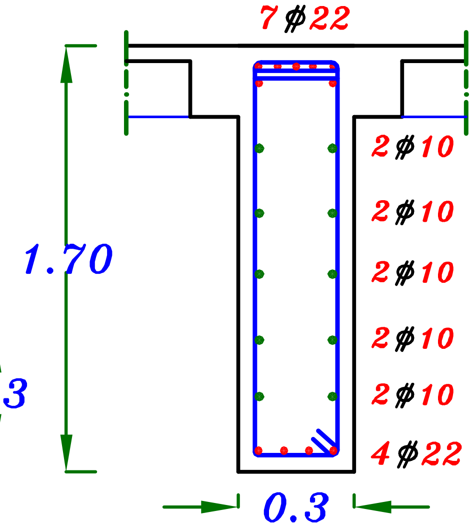
$\therefore$ Use Stirrups $\boxed{5 \phi 8 \backslash m'}$ 2 branches



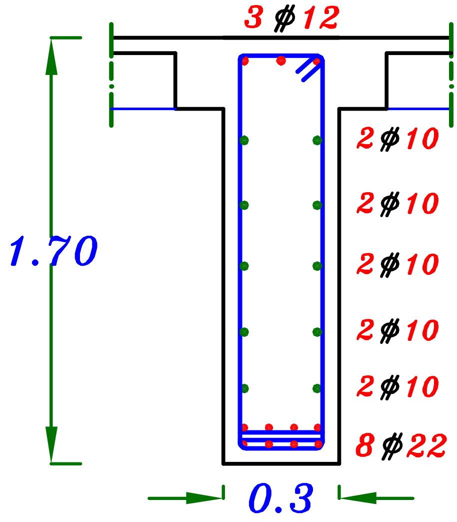




Sec. (2-2)

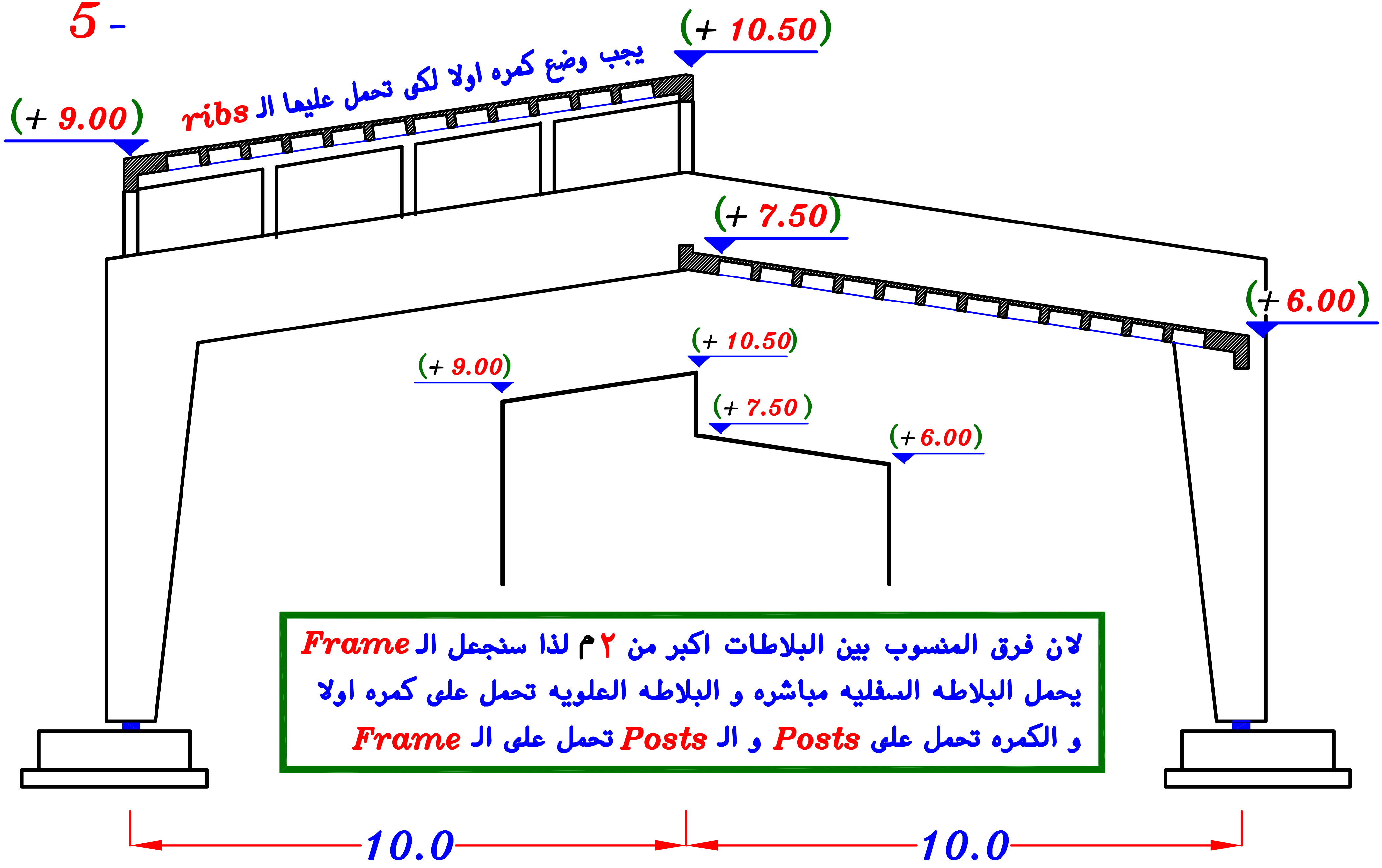


Sec. (1-1)



Sec. (3-3)

5 -



لان فرق المنسوب بين البلاطات اكبر من ٢م لذا سنجعل ال Frame
يحمل البلاطه السفليه مباشره و البلاطه العلويه تحمل على كمره اولا
و الكمره تحمل على Posts و ال Posts تحمل على ال Frame

Example.

Figure (1) shows a sectional elevation For an Industrial building of overall plan dimensions 28.0 m × 42.0 m , with 24.0 m clear span without any intermediate columns. The covering system consists of set of horizontal and inclined slabs where shown in the Figure. The level of horizontal slabs is 7.0 m From ground level. Only two sets of windows are allowed where shown in the Figure.

It is required to:

1 – Choose a convenient main system For the main supporting element and draw a sectional elevation and structural plan (to scale 1:50), showing all the structural elements with reasonably assumed concrete dimensions.

2 – Design the slab (a b c) ,then draw its details of reinforcement on the structural plan.

3 – Design the main supporting structural system, then draw its details of reinforcement in elevation (to scale 1:50) and sections (to scale 1:20).

Data:

F_{cu} = 30 MPa , st. 40/60 , Spacing between systems = 7.0 m

F.C. = 1.0 kN/m^2 , L.L. = 1.0 kN/m^2

Foundations level = (−1.50) m From ground level.

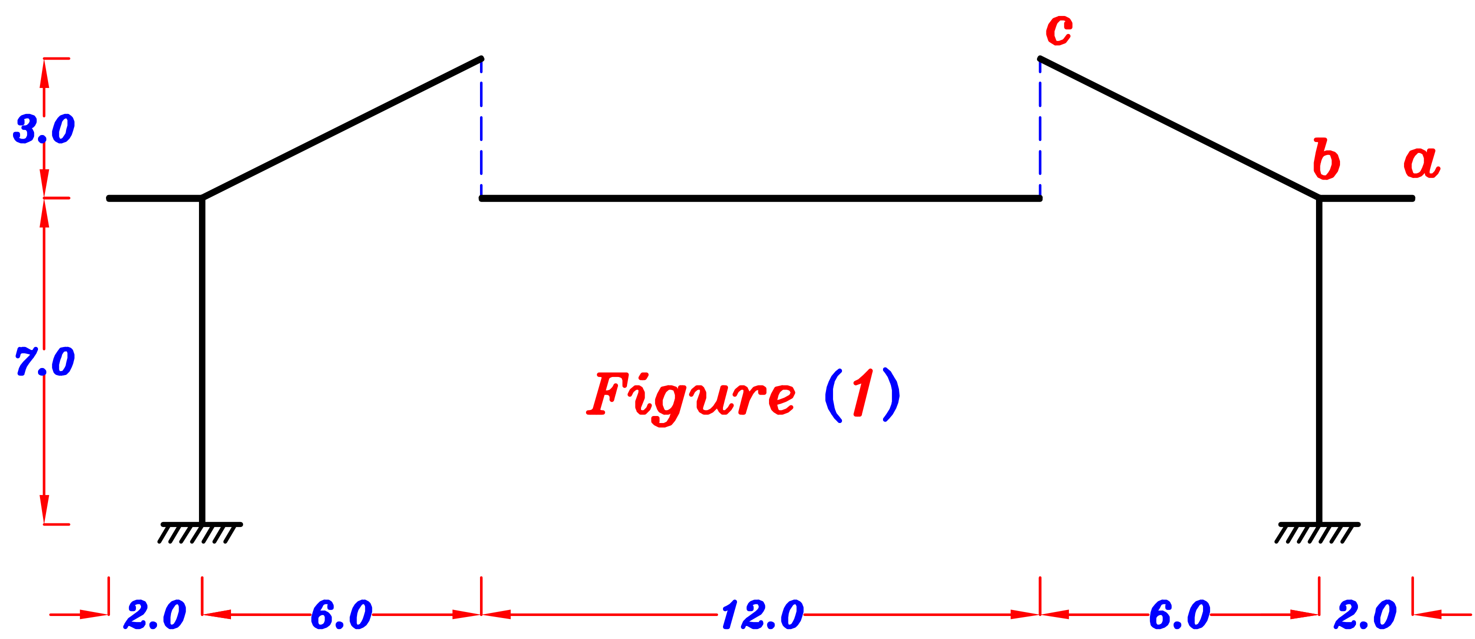
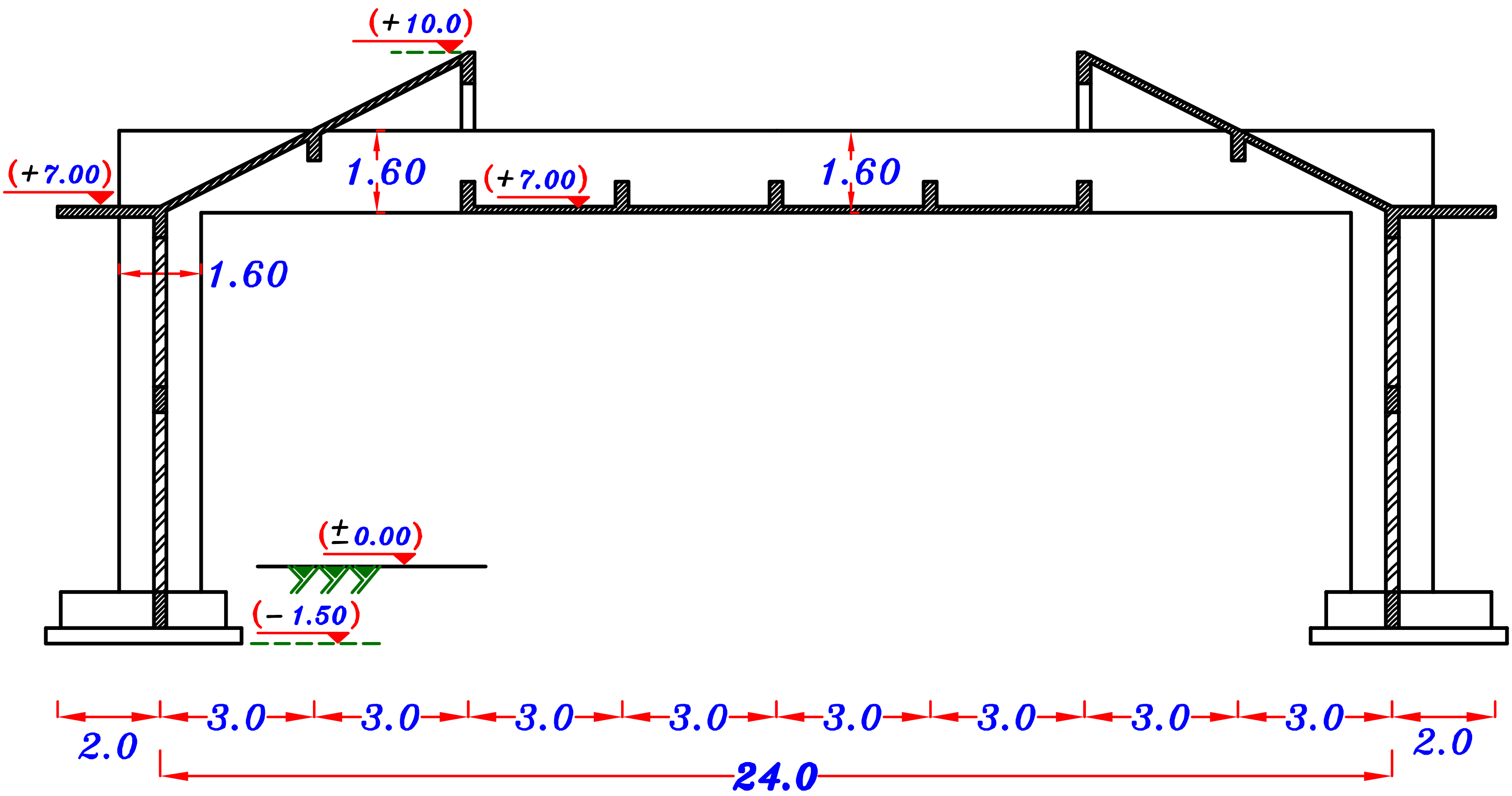


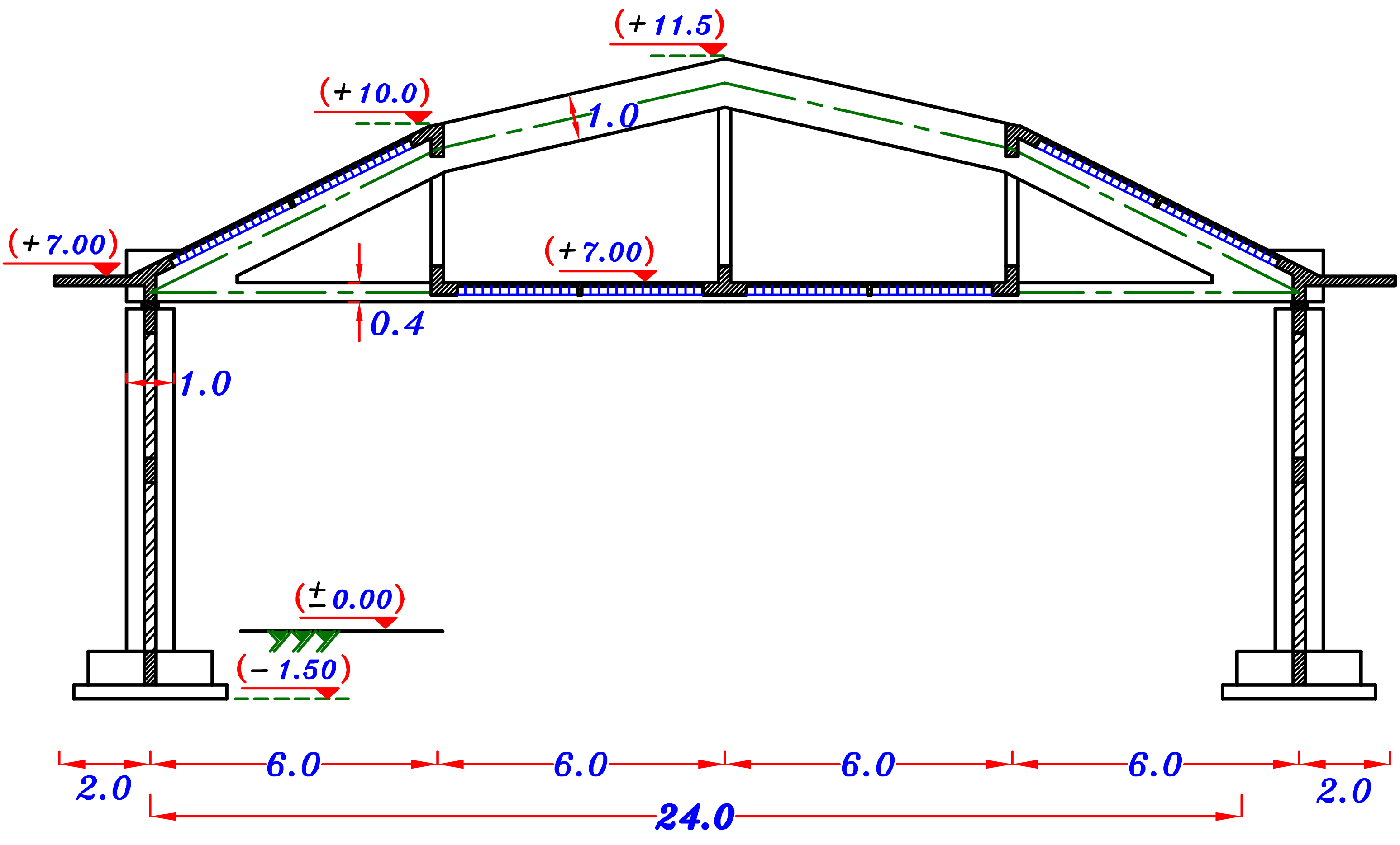
Figure (1)

1- There are 2 Systems can be used to cover this area.

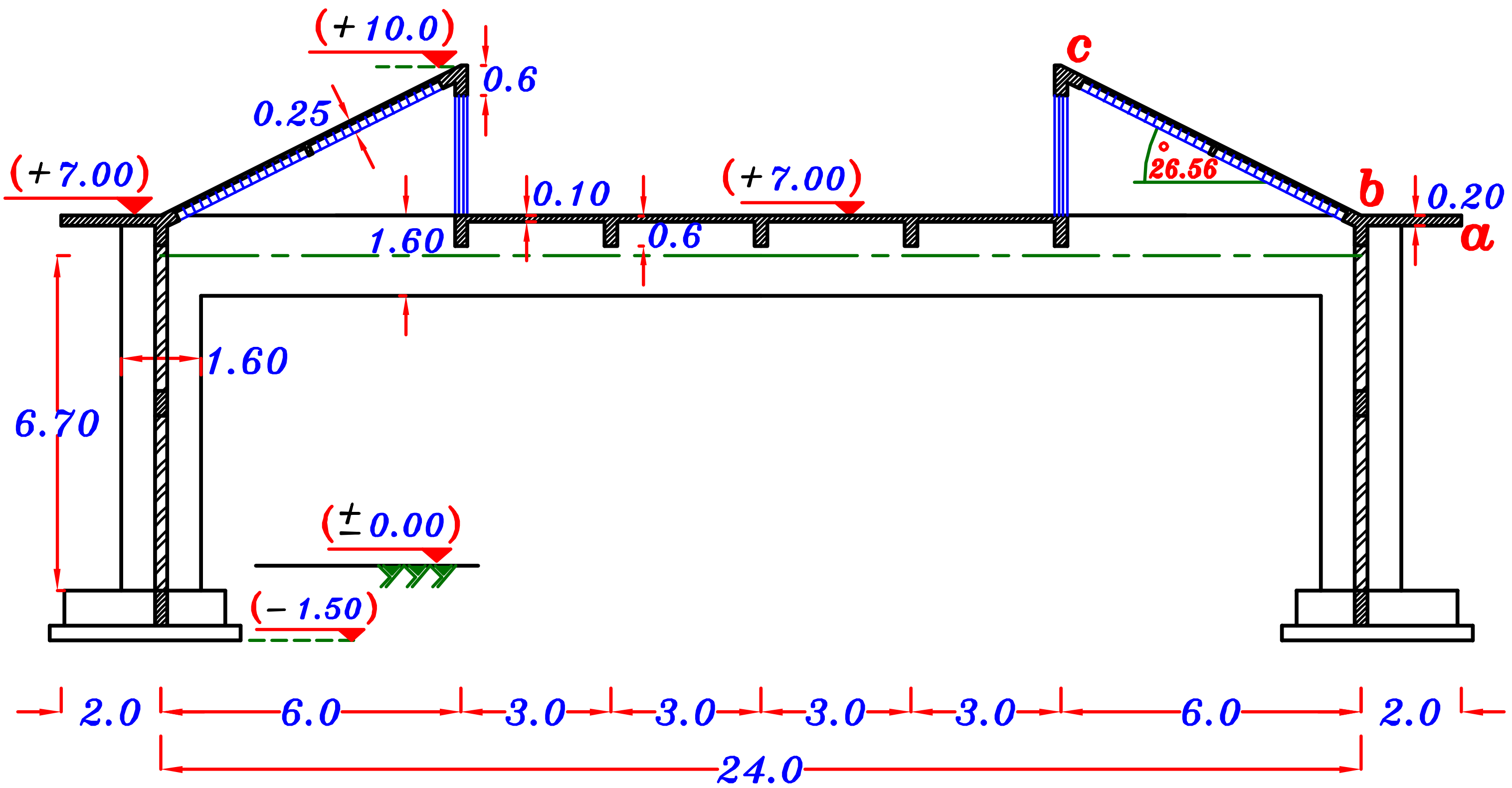
We can use **Fixed Frame.**

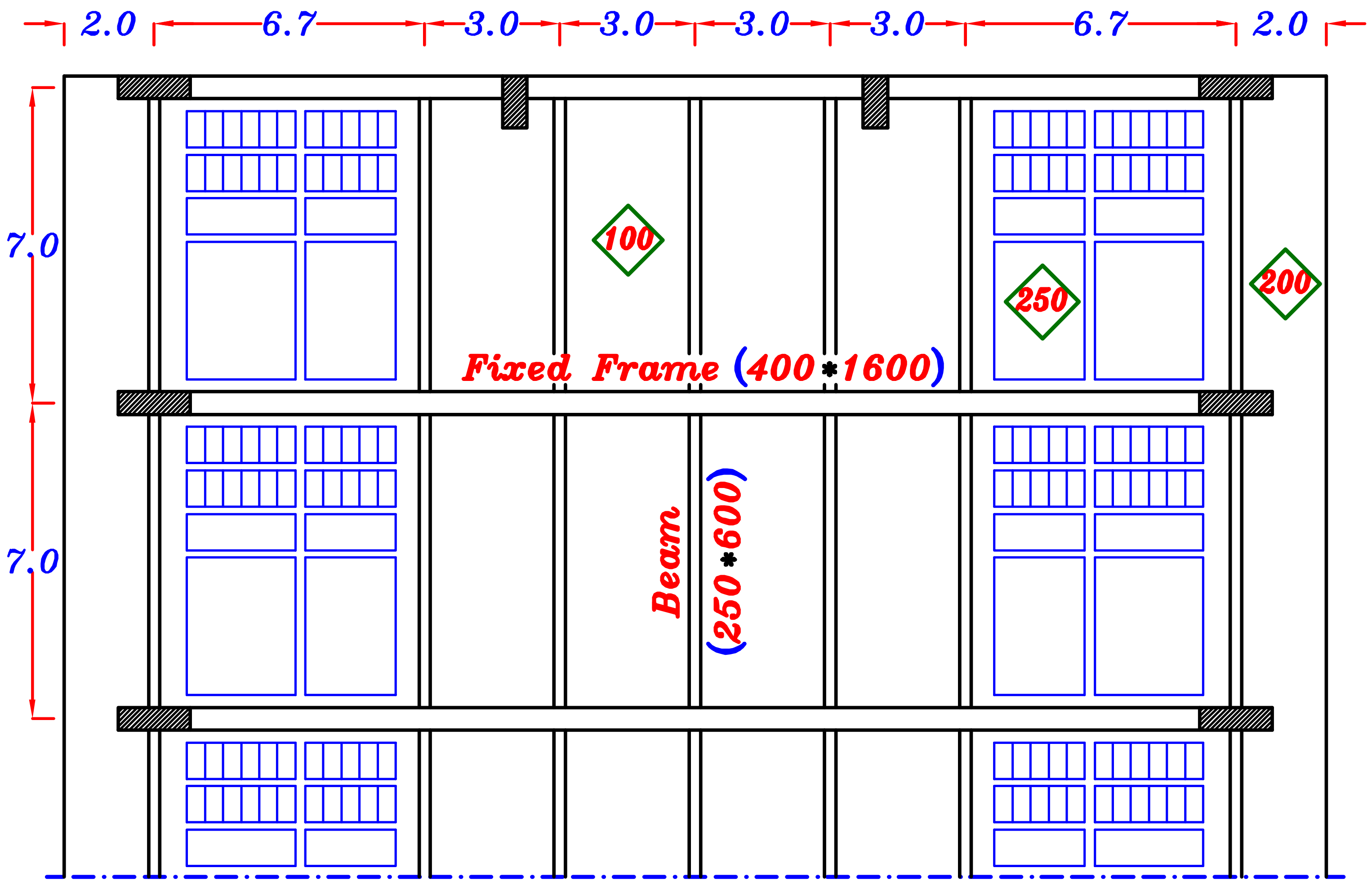


Or we can use **Arch Girder.**

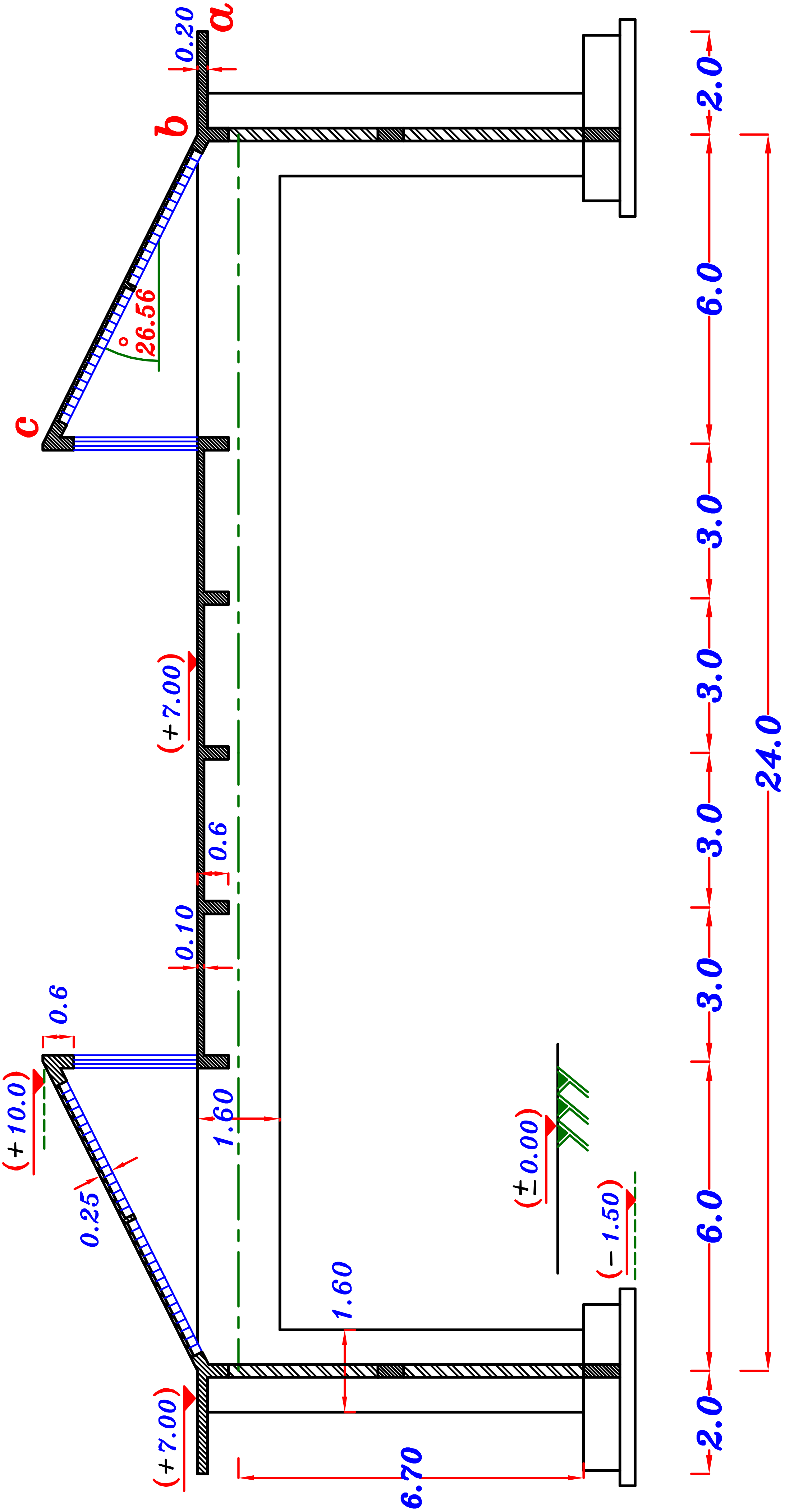


Use Fixed Frame.





Fixed Frame.


a
b
c
0.20
26.56°
(+7.00)
0.6
0.10
(+10.0)
0.25
1.60
1.60
(±0.00)
(− 1.50)
6.70
2.0
6.0
3.0
3.0
3.0
3.0
6.0
2.0
24.0

2 – Design the slab (a b c), then draw its details of reinforcement on the structural plan.

For cantilever Solid Slab. a b

$$t_s = \frac{2000}{10} = 200 \, mm$$

$$\boxed{w_s = 1.4 \, (t_s \, \gamma_c + F.C.) + 1.6 \, (L.L.)} \quad kN \backslash m^2$$

$$w_s = 1.4 \, (0.20 * 25 + 1.0) + 1.6 \, (1.0) = 10.0 \quad kN \backslash m^2$$

For Inclined H.B. Slab. b c Blocks (200 * 400 * 200)

$a = 200$ mm , $e = 400$ mm , $h = 200$ mm , $t_s = 50$ mm

$t = h + t_s = 200 + 50 = 250$ mm

$b = 100$ mm , $S = e + b = 400 + 100 = 500$ mm

$h = 200$ mm $\longrightarrow$ Weight of Block = 150 N

$$\boxed{\begin{aligned} w_{rib\,i} = & \left[1.4 \, (t_s \, \gamma_c + F.C.) + 1.6 (L.L.) \, Cos \, \theta \right] (S * 1.0) \\ & + 1.4 \, (b \, h * 1.0 m * \gamma_c) + 1.4 * (\text{Block وزن ال}) \left(\frac{1.0}{a} \right) \end{aligned}}$$

$$\therefore w_{rib\,i} = \left[1.4 \, (0.05 * 25 + 1.0) + 1.6 \, (1.0) \, (Cos \, 26.56) \right] (0.50 * 1.0)$$
$$+ 1.4 \, (0.10 * 0.20 * 1.0 * 25) + 1.4 \left(\frac{150}{1000} \right) \left(\frac{1.0}{0.2} \right) = 4.04$$
$$kN \backslash (1.0 * 0.5) m^2$$

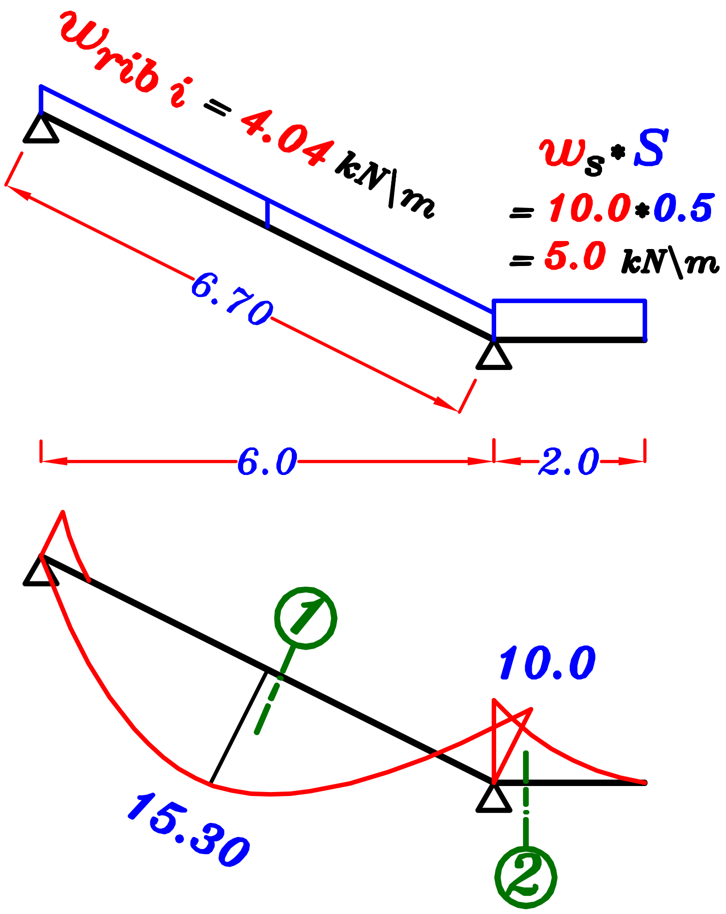
For the Horizontal Solid Slabs at the middle of the Frame.

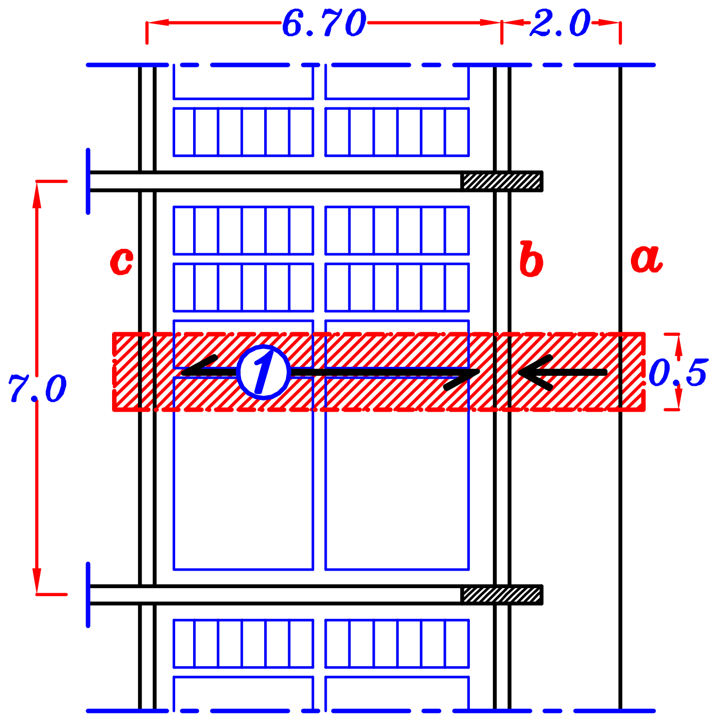
One way Solid slab $\quad t_s = \frac{L_s}{30} = \frac{3000}{30} = 100 \, mm$

$$\boxed{w_s = 1.4 \, (t_s \, \gamma_c + F.C.) + 1.6 \, (L.L.)} \quad kN \backslash m^2$$

$$w_s = 1.4 \, (0.10 * 25 + 1.0) + 1.6 \, (1.0) = 6.50 \quad kN \backslash m^2$$

Strip a b c





Sec. ① **H.B.** $M_{U.L.} = 15.30$ kN.m\rib

$t = 250$ mm , $d = 250 - 30 = 220$ mm , $S = 500$ mm عرض الشريحه

$$220 = C_1 \sqrt{\frac{15.30 * 10^6}{30 * 500}} \longrightarrow C_1 = 6.88 \longrightarrow J = 0.826$$

$$A_s = \frac{15.30 * 10^6}{0.826 * 400 * 220} = 210.5 \ mm^2/rib$$

2Φ12\rib

Sec. ② **S.S.** $M_{U.L.} = 10.0$ kN.m\ 0.50 m

$t_s = 200$ mm , $d = 200 - 20 = 180$ mm , $S = 500$ mm عرض الشريحه

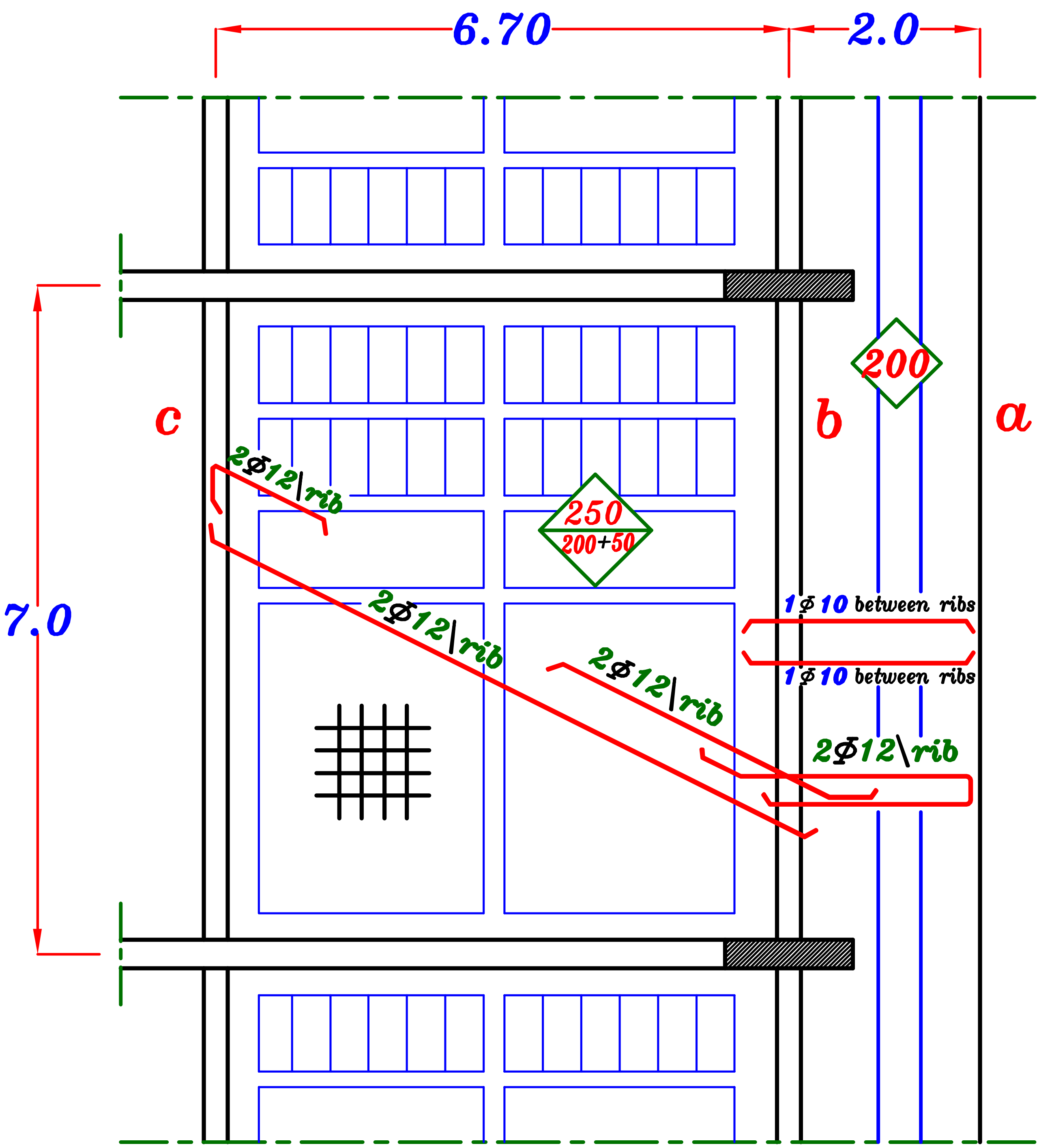
$$180 = C_1 \sqrt{\frac{10.0 * 10^6}{30 * 500}} \longrightarrow C_1 = 6.97 \longrightarrow J = 0.826$$

$$A_s = \frac{10.0 * 10^6}{0.826 * 400 * 180} = 168.14 \ mm^2/rib$$

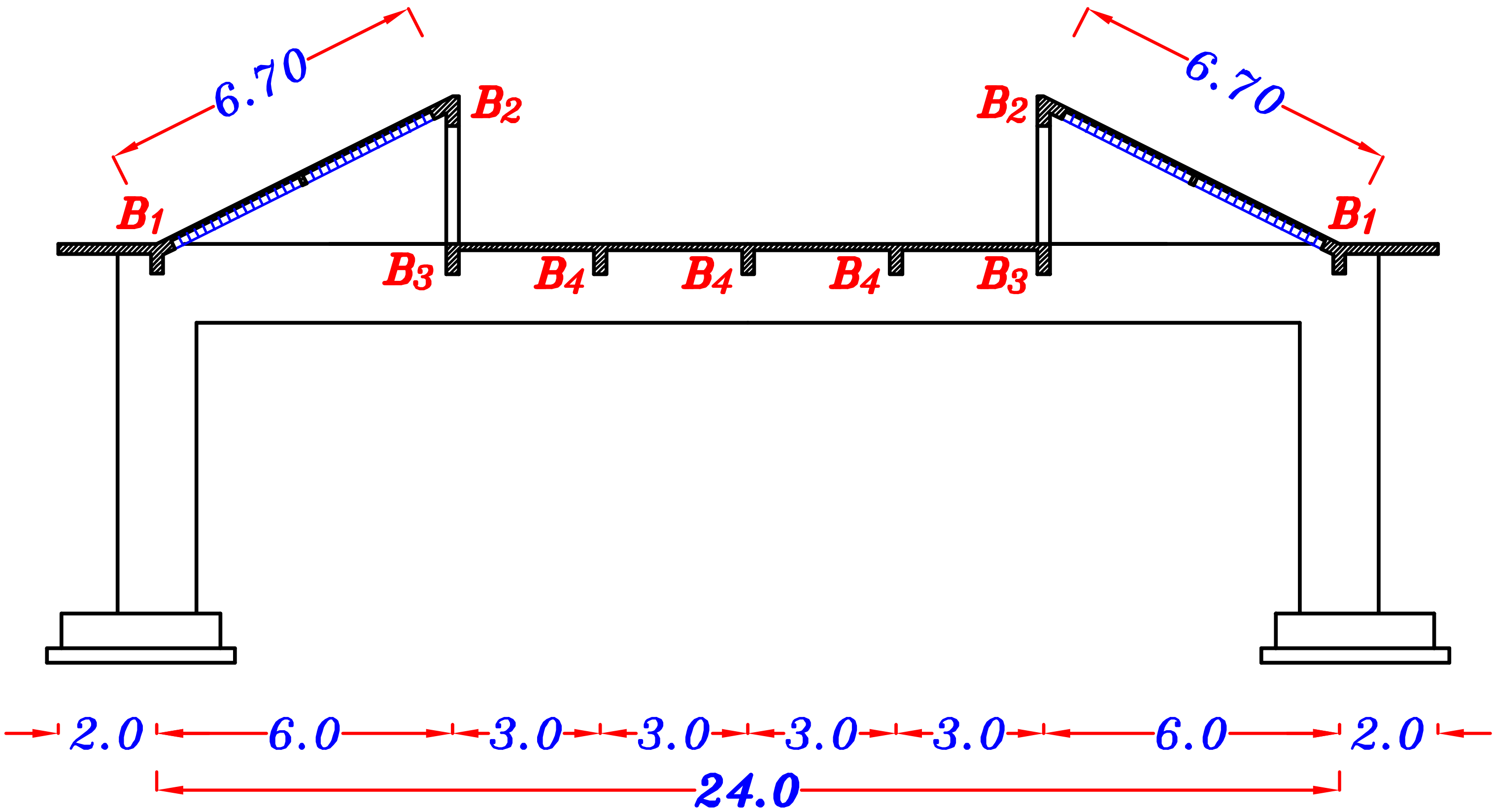
2Φ12\rib

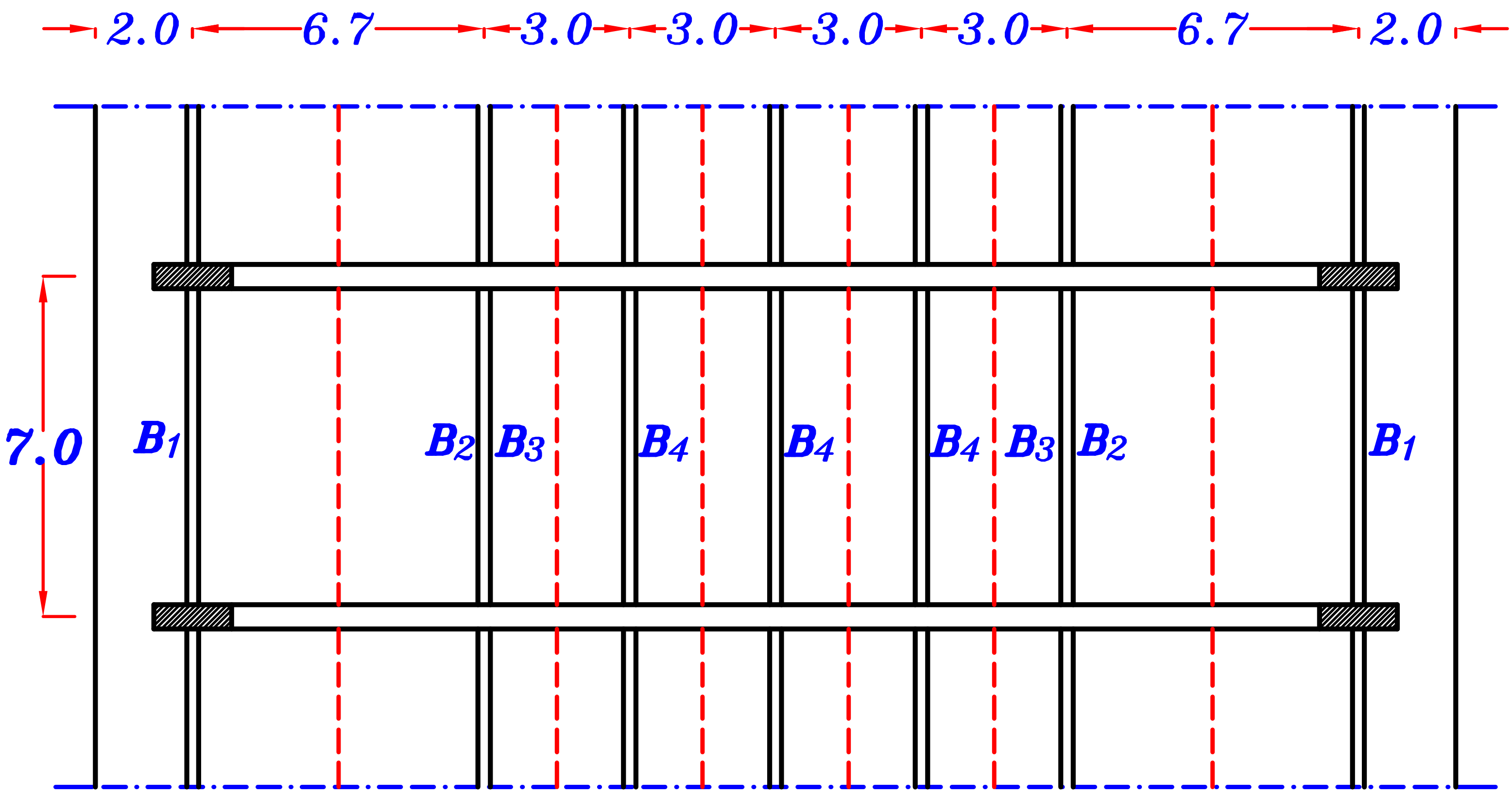
التسليح rib\ لانه يوجد تداخل بين ال S.S. & H.B.

RFT. of Slab a b c



3 – Design the main supporting structural system, then draw its details of reinforcement in elevation (to scale 1:50) and sections (to scale 1:20).





Take all secondary Beams $(250 * 600)$

$o.w._{(Beams)} = 1.4 * 0.25 * 0.60 * 25 = 5.25\ kN/m$

Frame $(400 * 1600)$

$o.w._{(Frame)} = 1.4 * 0.40 * 1.60 * 25 = 22.4\ kN/m$

$w_s = 10.0\ kN\backslash m^2$ For Cantilever solid Slab

$w_s = 6.50\ kN\backslash m^2$ For One way solid Slab

$w_{rib} = 4.04\ kN\backslash(1.0 * 0.5)$ For One way H.B.

Load Distribution.

B1

$$w = o.w. + w_s * L_c + \frac{w_{rib}}{S} * \frac{L_s}{2}$$

$$w = 5.25 + 10.0 * 2.0 + \frac{4.04}{0.5} * \frac{6.70}{2} = 52.32\ kN/m$$

$$R_1 = w * S = 52.32 * 7.0 = 366.24\ kN$$

B2

$$w = o.w. + \frac{w_{rib}}{S} * \frac{L_s}{2} = 5.25 + \frac{4.04}{0.5} * \frac{6.70}{2} = 32.32\ kN/m$$

$$R_2 = w * S = 32.32 * 7.0 = 226.24\ kN$$

B3

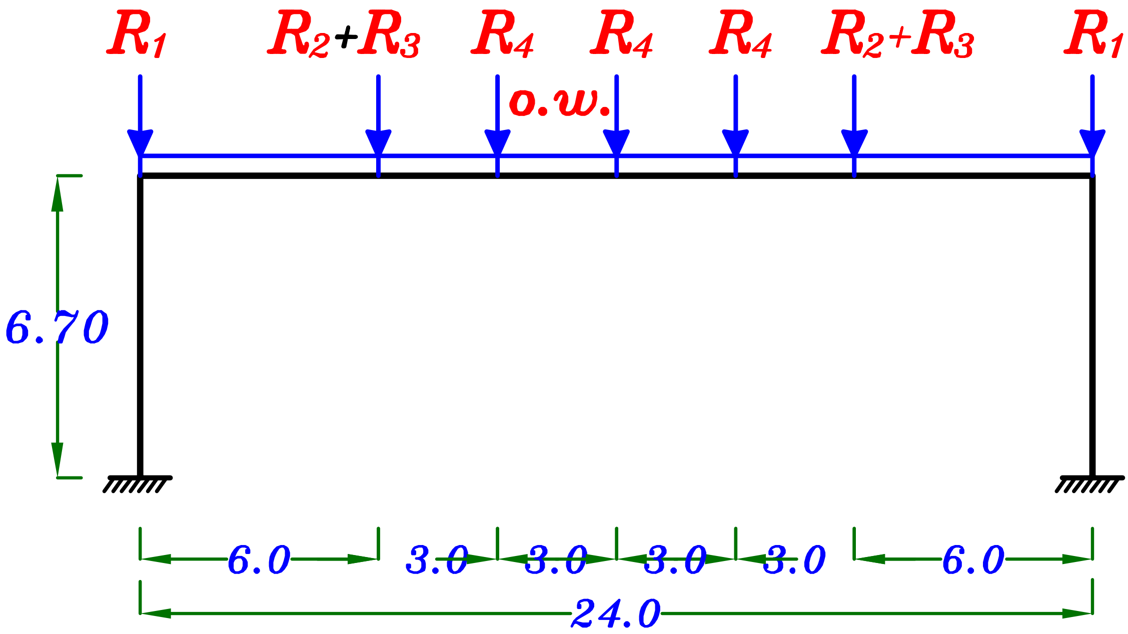
$$w = o.w. + w_s * \frac{L_s}{2} = 5.25 + 6.50 * \frac{3.0}{2} = 15.0\ kN/m$$

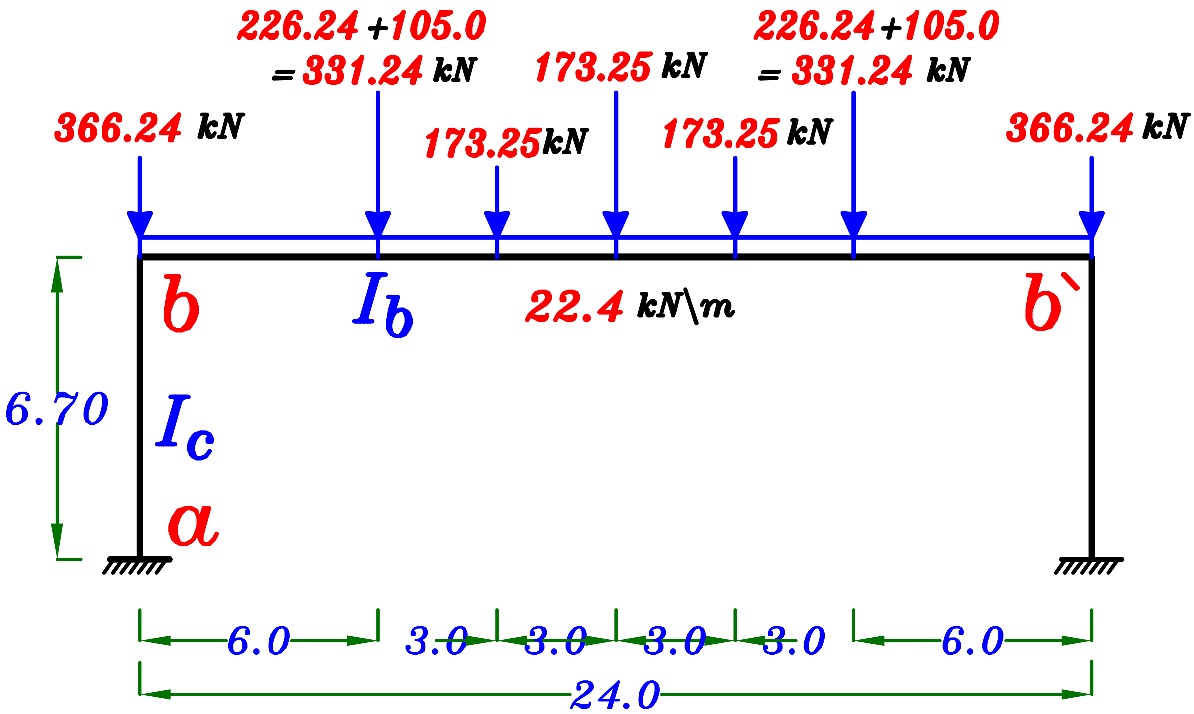
$$R_3 = w * S = 15.0 * 7.0 = 105.0\ kN$$

B4

$$w = o.w. + 2 * w_s * \frac{L_s}{2} = 5.25 + 2 * 6.50 * \frac{3.0}{2} = 24.75\ kN/m$$

$$R_4 = w * S = 24.75 * 7.0 = 173.25\ kN$$





$$I_c = I_b = \frac{b\,(t)^3}{12} = \frac{0.4\,(1.60)^3}{12} = 0.136\ m^4$$

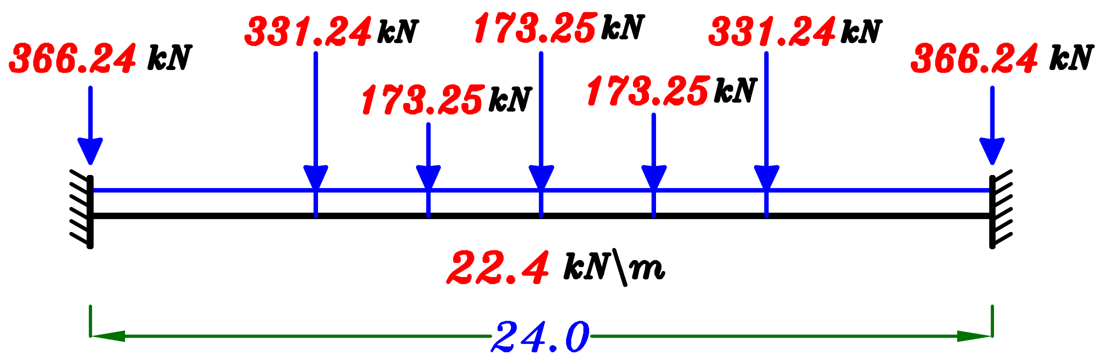
For Joint $\underline{\underline{b}}$

$$K_c = \frac{I_c}{h} = \frac{I_c}{6.70} = 0.149 I_c$$

$$K_b = \frac{1}{2}\,\frac{I_b}{L} = \frac{1}{2} * \frac{I_b}{24.0} = 0.0208\ I_b = 0.0208\ I_c$$

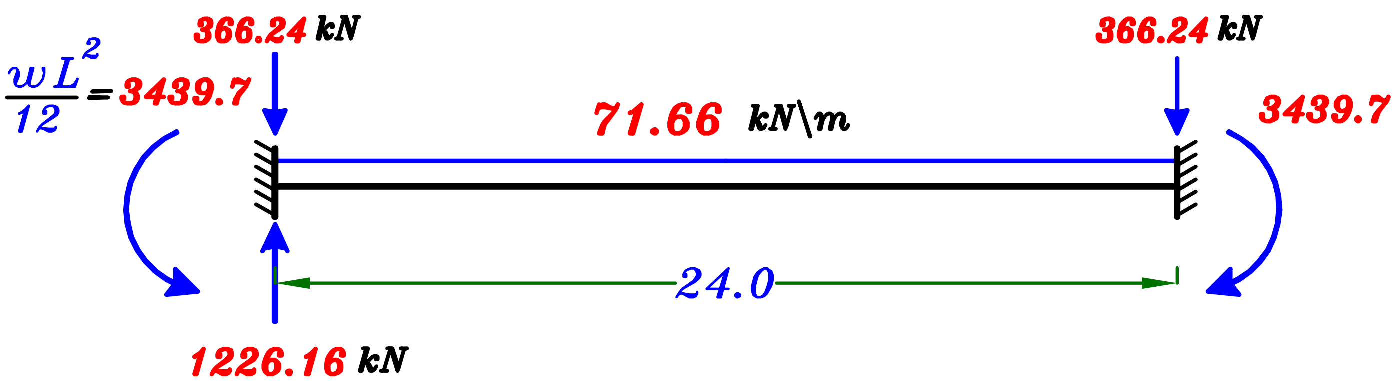
$$D.F._{(c)} = \frac{0.149}{0.149 + 0.0208} = 0.877$$

$$D.F._{(b)} = 1 - 0.877 = 0.123$$

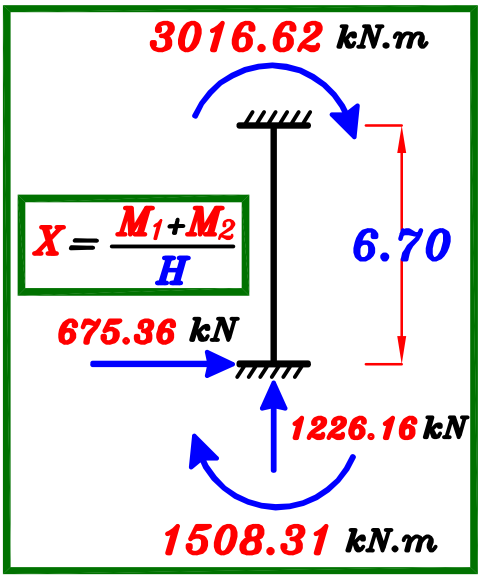


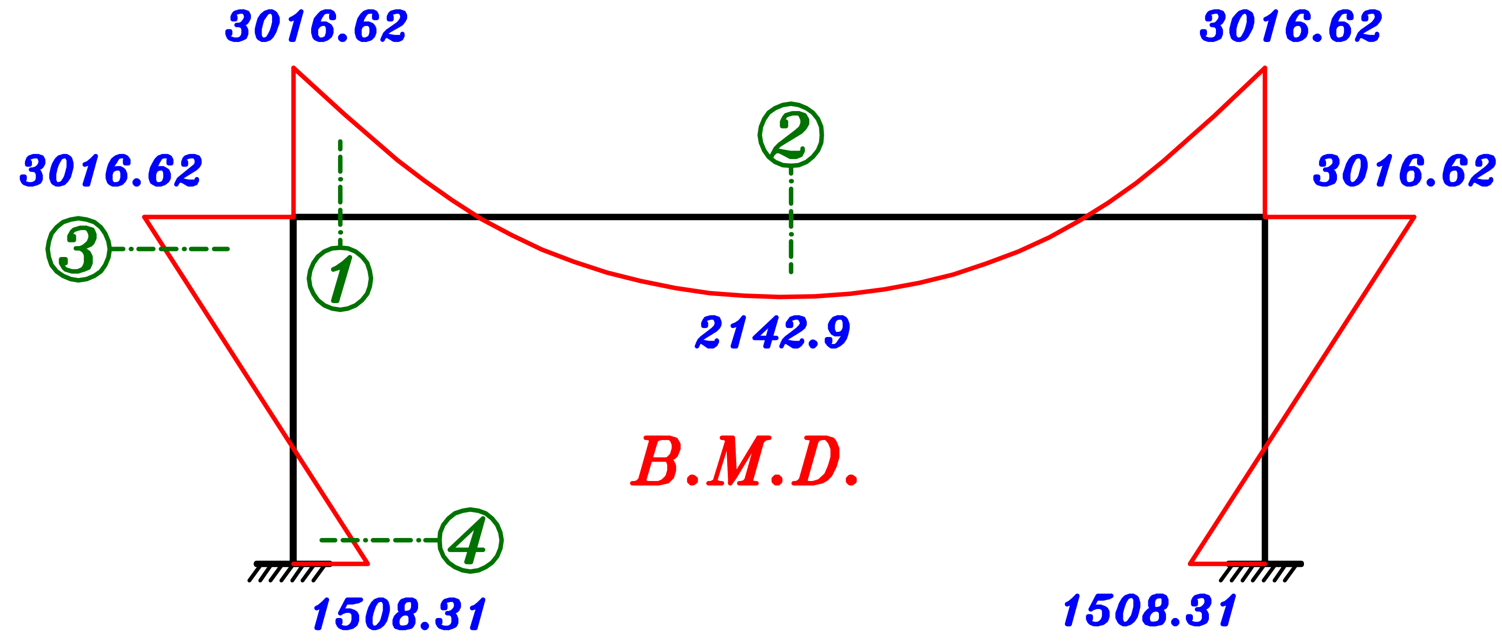
$$w = o.w. + \frac{\sum P}{span} = 22.4 + \frac{2\,(331.24) + 3\,(173.25)}{24.0} = 71.66 \text{ kN\m'}$$

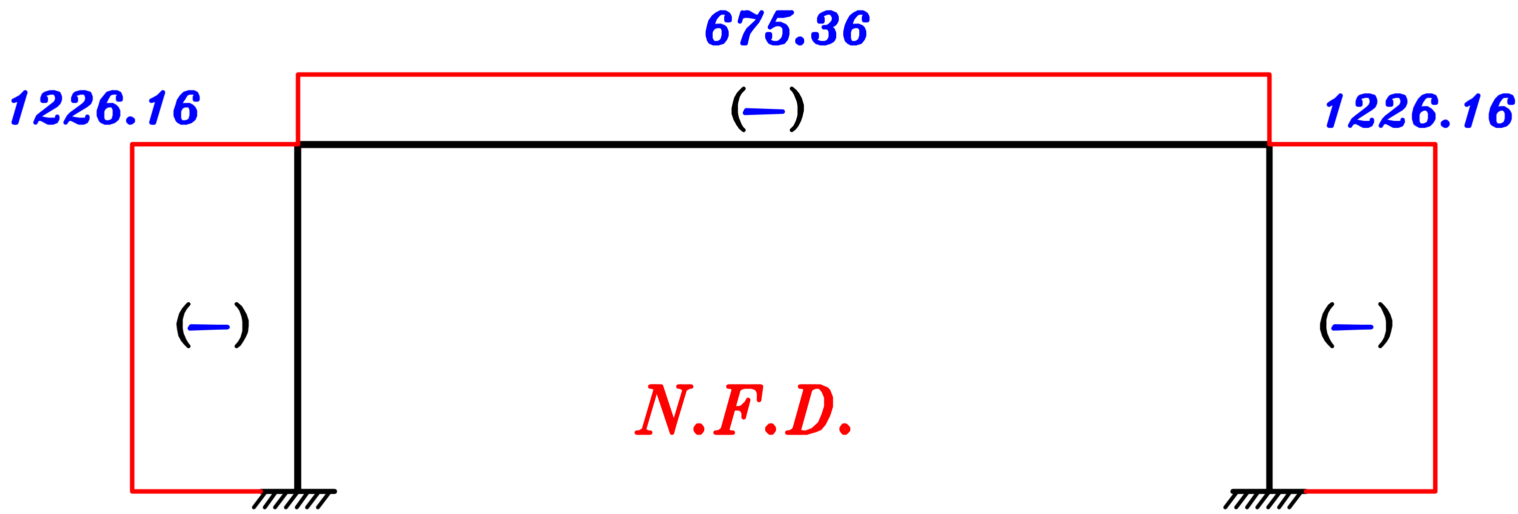
$$\frac{wL^2}{12} = \frac{71.66 * (24.0)^2}{12} = 3439.7 \text{ kN.m}$$



$$F.E.M.(Beam) * D.F.(Col.) = 3439.7 * 0.877 = 3016.62 \text{ kN.m}$$







Design of Sections.

Sec. ① R–Sec.

$M = 3016.62$ kN.m , $P = 675.36$ kN , $b = 400$ mm , $t = 1600$ mm

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{675.36 * 10^{3}}{30 * 400 * 1600} = 0.035 < 0.04$ (neglect P)

$\therefore 1500 = C_1 \sqrt{\dfrac{3016.62 * 10^{6}}{30 * 400}} \longrightarrow C_1 = 2.99 \longrightarrow J = 0.742$

$\therefore A_s = \dfrac{M_{U.L.}}{J\, F_y\, d} = \dfrac{3016.62 * 10^{6}}{0.742 * 400 * 1500} = 6775.9 \text{ mm}^2$

Check $A_{s\,min.}$ $A_{s_{req.}} = 6775.9\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{400}\right) 400 * 1500 = 1848.6\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 6775.9\ mm^2$ **14Φ25**

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{25 + 25} = 7.50 = 7.5 \text{ bars}$$

Sec. ② R-Sec.

$M = 2142.9$ kN.m , $P = 675.36$ kN , $b = 400$ mm , $t = 1600$ mm

$$\text{Check } \frac{P}{F_{cu}\, b\, t} = \frac{675.36 * 10^3}{30 * 400 * 1600} = 0.035 < 0.04 \quad (\text{neglect } P)$$

$$\therefore 1500 = C_1 \sqrt{\frac{2142.9 * 10^6}{30 * 400}} \longrightarrow C_1 = 3.55 \longrightarrow J = 0.784$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{2142.9 * 10^6}{0.784 * 400 * 1500} = 4555.5\ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 4555.5\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{400}\right) 400 * 1500 = 1848.6\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 4555.5\ mm^2$ **10Φ25**

Sec. ③ R-Sec.

Neglect Effect of Buckling.

$M = 3016.62$ kN.m , $P = 1226.16$ kN , $b = 400$ mm , $t = 1600$ mm

$$\text{Check } \frac{P}{F_{cu}\, b\, t} = \frac{1226.16 * 10^3}{30 * 400 * 1600} = 0.064 > 0.04 \quad (\text{Don't neglect } P)$$

$$e_s = e + \frac{t}{2} - c = 2.46 + \frac{1.6}{2} - 0.1 = 3.16 \ m$$

$$M_s = P * e_s = 1226.16 * 3.16 = 3874.67 \ kN.m$$

$$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} \quad \therefore 1500 = C_1 \sqrt{\frac{3874.67 * 10^6}{30 * 400}} \rightarrow C_1 = 2.64 < 2.78$$

$\therefore$ The section is over reinforced

$\therefore$ Increase depth or use A_s' From I.D.

$\therefore$ <u>Increase depth</u>

To choose minimum depth that make the section under reinforced

Take $C_1 = 2.78$

$$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} = 2.78 \sqrt{\frac{3874.67 * 10^6}{30 * 400}} = 1579.7 \ mm$$

$\therefore$ Choose $\boxed{d = 1600 \ mm}$, $\boxed{t = 1700 \ mm}$

Check $\frac{P}{F_{cu}\, b\, t} = \frac{1226.16 * 10^3}{30 * 400 * 1700} = 0.060 > 0.04$ (Don't neglect P)

$$e = \frac{M}{P} = \frac{3016.62}{1226.16} = 2.46 \ m \quad \therefore \frac{e}{t} = \frac{2.46}{1.70} = 1.447 > 0.5 \xrightarrow{use} e_s$$

$$e_s = e + \frac{t}{2} - c = 2.46 + \frac{1.7}{2} - 0.1 = 3.21 \ m$$

$$M_s = P * e_s = 1226.16 * 3.21 = 3935.97 \ kN.m$$

$$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} \quad \therefore 1600 = C_1 \sqrt{\frac{3935.97 * 10^6}{30 * 400}} \rightarrow C_1 = 2.79 \rightarrow J = 0.718$$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \delta_s)} = \frac{3935.97 * 10^6}{0.718 * 400 * 1600} - \frac{1226.16 * 10^3}{(400 \backslash 1.15)}$$

$$= 5040.2 \ mm^2$$

<u>Check $A_{s\,min.}$</u> $\quad A_{s_{req.}} = 5040.2 \ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{400}\right) 400 * 1600 = 1971.8 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore Take \ A_s = A_{s_{req.}} = 5040.2 \ mm^2 \quad 11 \Phi 25$$

Sec. 4 R–Sec.

Neglect Effect of Buckling.

$M = 1508.31$ kN.m , $P = 1226.16$ kN , $b = 400$ mm , $t = 1700$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{1226.16 * 10^3}{30 * 400 * 1700} = 0.060 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{1508.31}{1226.16} = 1.23$ m $\quad \therefore \frac{e}{t} = \frac{1.23}{1.70} = 0.72 > 0.5 \xrightarrow{use} e_s$

$e_s = e + \frac{t}{2} - c = 1.23 + \frac{1.7}{2} - 0.1 = 1.98$ m

$M_s = P * e_s = 1226.16 * 1.98 = 2427.80$ kN.m

$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} \quad \therefore 1600 = C_1 \sqrt{\frac{2427.80 * 10^6}{30 * 400}} \rightarrow C_1 = 3.55 \rightarrow J = 0.784$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{2427.80 * 10^6}{0.784 * 400 * 1600} - \frac{1226.16 * 10^3}{(400 \backslash 1.15)}$$

$$= 1313.36 \text{ mm}^2$$

Check $A_{s_{min.}}$ $\qquad A_{s\,req.} = 1313.36$ mm^2

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{400}\right) 400 * 1600 = 1971.8$ mm^2

$\therefore \mu_{min.}\, b\, d > A_{s\,req.} \xrightarrow{Use} A_{s_{min.}}$

$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\, b\, d = \left(0.225 * \frac{\sqrt{30}}{400}\right) 400 * 1600 = 1971.8$ } الأقل $= 1707.37$

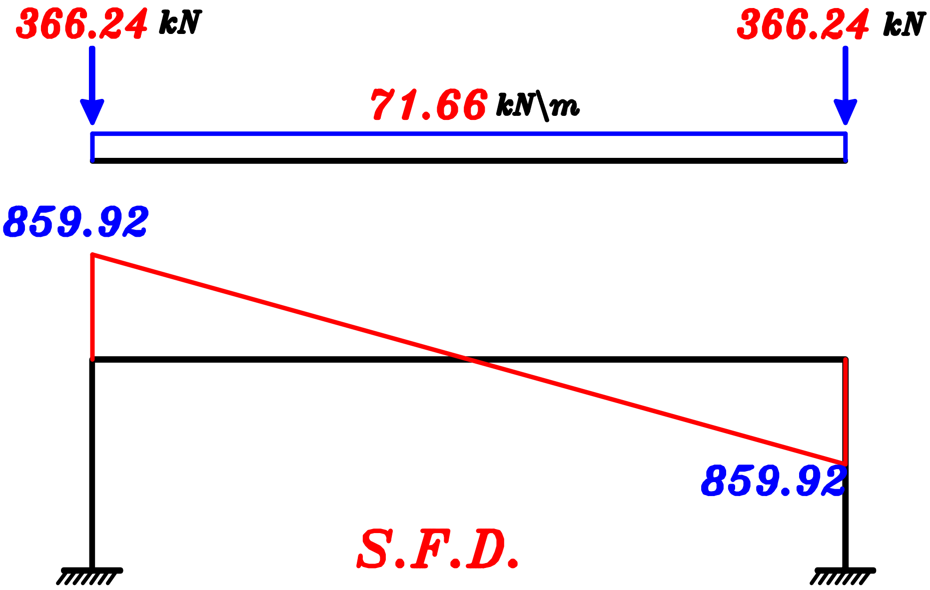
$1.3\, A_{s\,req.} = 1.3 * 1313.36 = 1707.37$

الأكبر $= 1707.37$ mm^2

st. 400/600 $\quad \frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 400 * 1600 = 960$

4 Φ 25

Check Shear.



$$q_U = \frac{Q_{max}}{b\ d} = \frac{859.92 * 10^3}{400 * 1500} = 1.43\ N\backslash mm^2$$

$$q_{cu} = 0.24\sqrt{\frac{F_{cu}}{\gamma_c}} = 0.24\sqrt{\frac{30}{1.5}} = 1.07\ N\backslash mm^2$$

$$q_{cu} = 0.70\sqrt{\frac{F_{cu}}{\gamma_c}} = 0.70\sqrt{\frac{30}{1.5}} = 3.13\ N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\therefore$ We need Stirrups more Than $5\phi 8\backslash m'$

$$\therefore \text{ Use } q_s = q_u - \frac{q_{cu}}{2} = \frac{n A_s (F_y \backslash \gamma_s)}{b\ S}$$

* Take $n = 2$, $\phi\ 8 \longrightarrow A_s = 50.3\ mm^2$

$$1.43 - \frac{1.07}{2} = \frac{2 * 50.3\ (240\backslash 1.15)}{400 * S} \longrightarrow S = 58.64\ mm < 100\ mm$$

* Take $n = 2$, $\phi\ 10 \longrightarrow A_s = 78.5\ mm^2$

$$1.43 - \frac{1.07}{2} = \frac{2 * 78.5\ (240\backslash 1.15)}{400 * S} \longrightarrow S = 91.5\ mm < 100\ mm$$

* Take $n = 4$, $\phi\ 8 \longrightarrow A_s = 50.3\ mm^2$

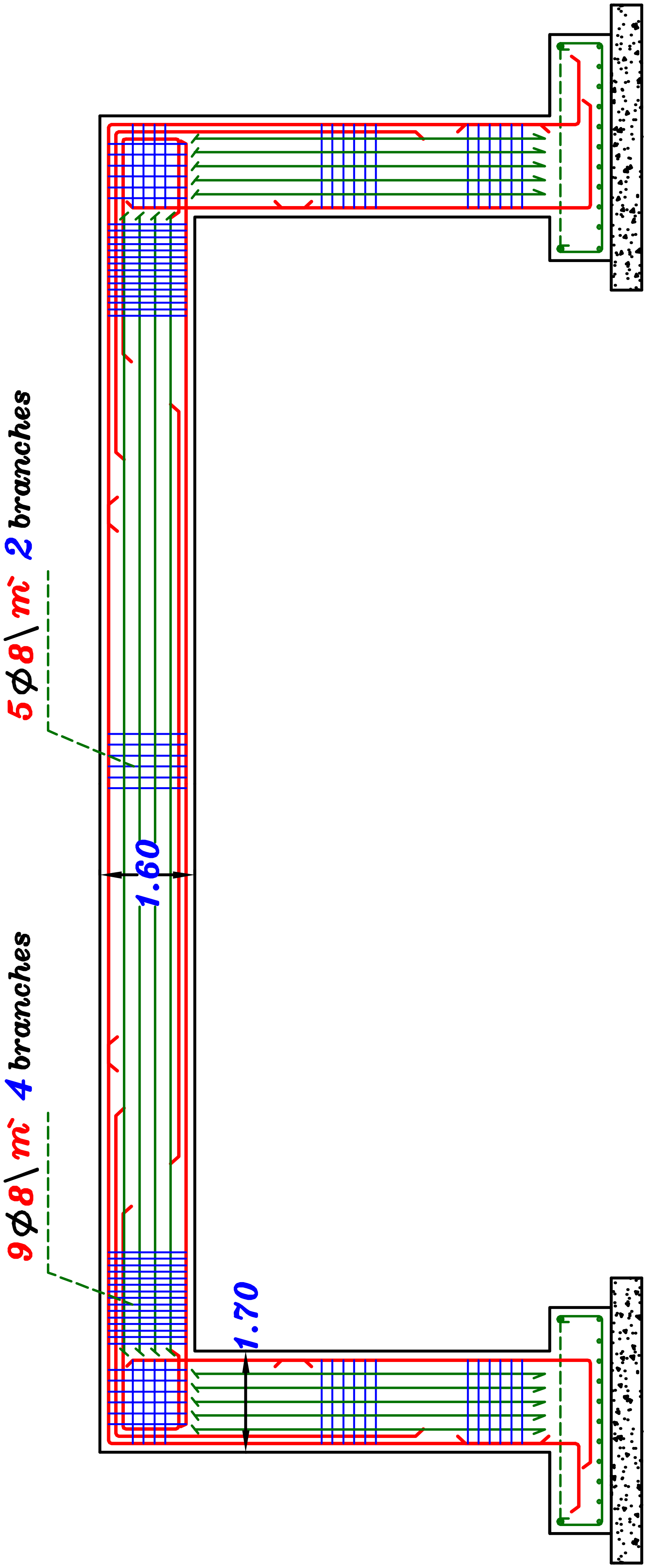
$$1.43 - \frac{1.07}{2} = \frac{4 * 50.3\ (240\backslash 1.15)}{400 * S} \longrightarrow S = 117.29\ mm > 100\ mm$$

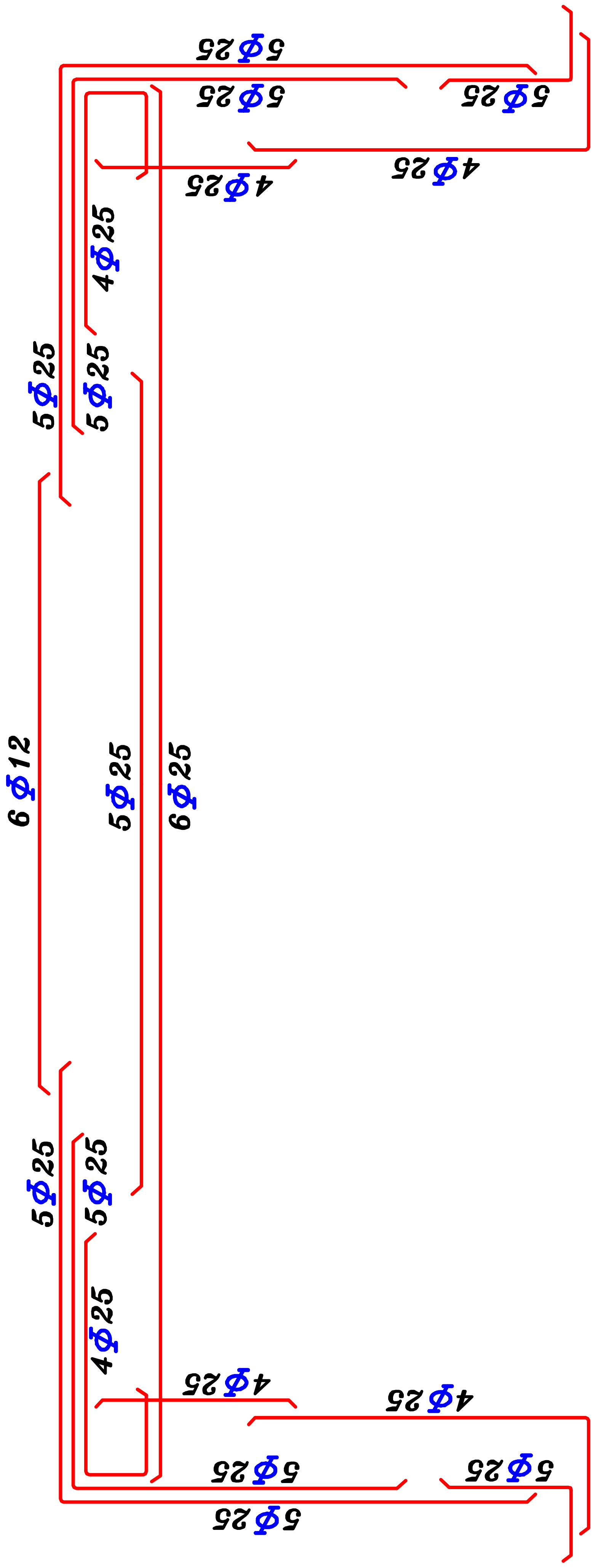
$\therefore$ o.k.

$$\therefore \text{ No. of stirrups}\backslash m' = \frac{1000}{S} = \frac{1000}{117.29} = 8.52 = 9$$

$\therefore$ Use Stirrups $\boxed{9\phi 8\backslash m' \quad 4 \text{ branches}}$

RFT. of Frame.




5Φ25
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6Φ12
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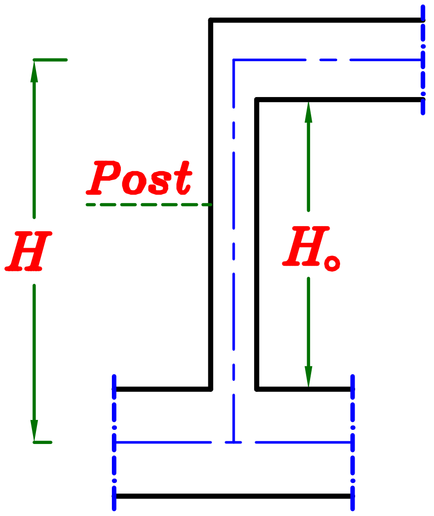
Note.

Posts.



اذا كان الارتفاع (H_o) لل post

اقل من او يساوى ٢,٥٠ م

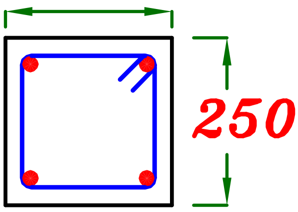
فعاده يكون Short Column

و عاده يؤخذ القطاع (250 * 250)

و التسليح 4 Φ 12

Short Column

4 Φ 12



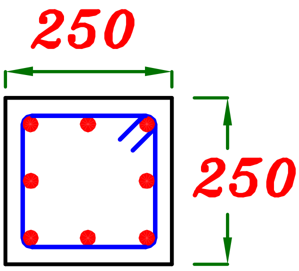
اذا كان الارتفاع (H_o) لل post يتراوح من ٢,٥٠ م الى ٤,٠ - م

فسيتحول الى Long Column و لكن يظل القطاع (250 * 250)

و سنأخذ التسليح 8 Φ 12

Long Column

8 Φ 12



اذا كان الارتفاع (H_o) لل post اكبر من ٤,٠ - م

فهذا حل غير مفضل و اذا اضطررنا له سنجعل القطاع (b * b)

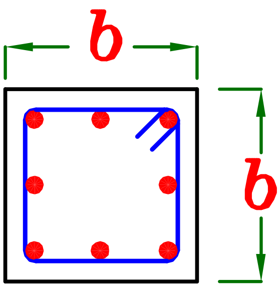
حيث b عرض ال system الذى يحمل ال post

و يعتبر Long Column

و سنأخذ التسليح 8 Φ 12

Long Column

8 Φ 12



Hangers.

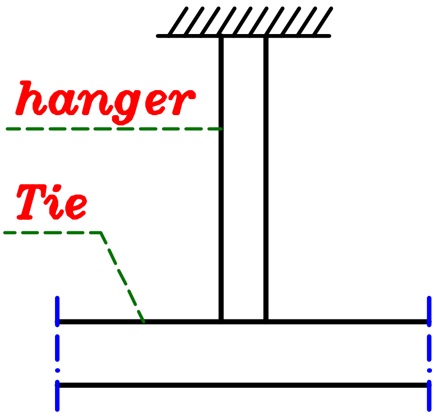
ال ***Hangers*** يؤثر عليها ***tension*** لذا الارتفاع لن يؤثر عليها

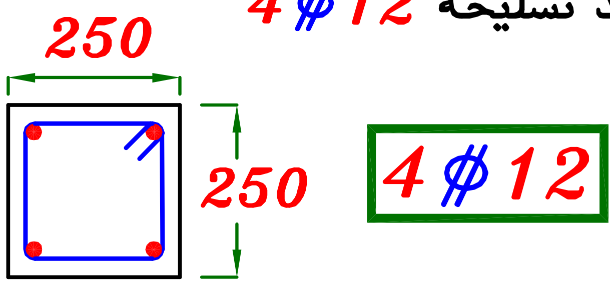
لانه لا يوجد عليها ***buckling*** لذا عاده نأخذ ابعاد القطاع **(250 * 250)**

مهما كان الارتفاع .

اذا كان ال ***Hanger*** يحمل وزن ال ***Tie*** فقط

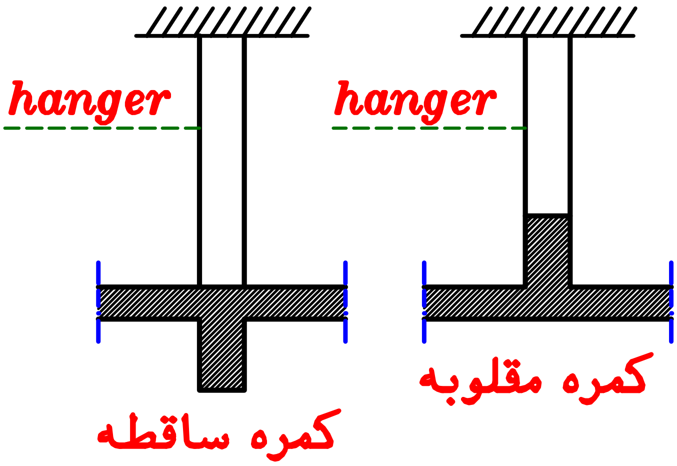
فعاده نأخذ تسليحه **4 Ø 12**

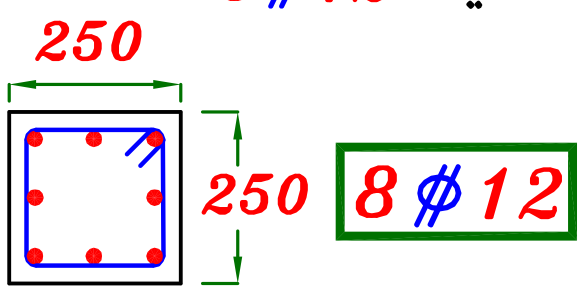




اذا كان ال ***Hanger*** يحمل وزن كمره

فعاده نأخذ تسليحه **8 Ø 12**





لن يفرق اذا كانت الكمره ساقطه او مقلوبه لانه فى الحالتين

سيدخل تسليح ال ***Hanger*** داخل الكمره .

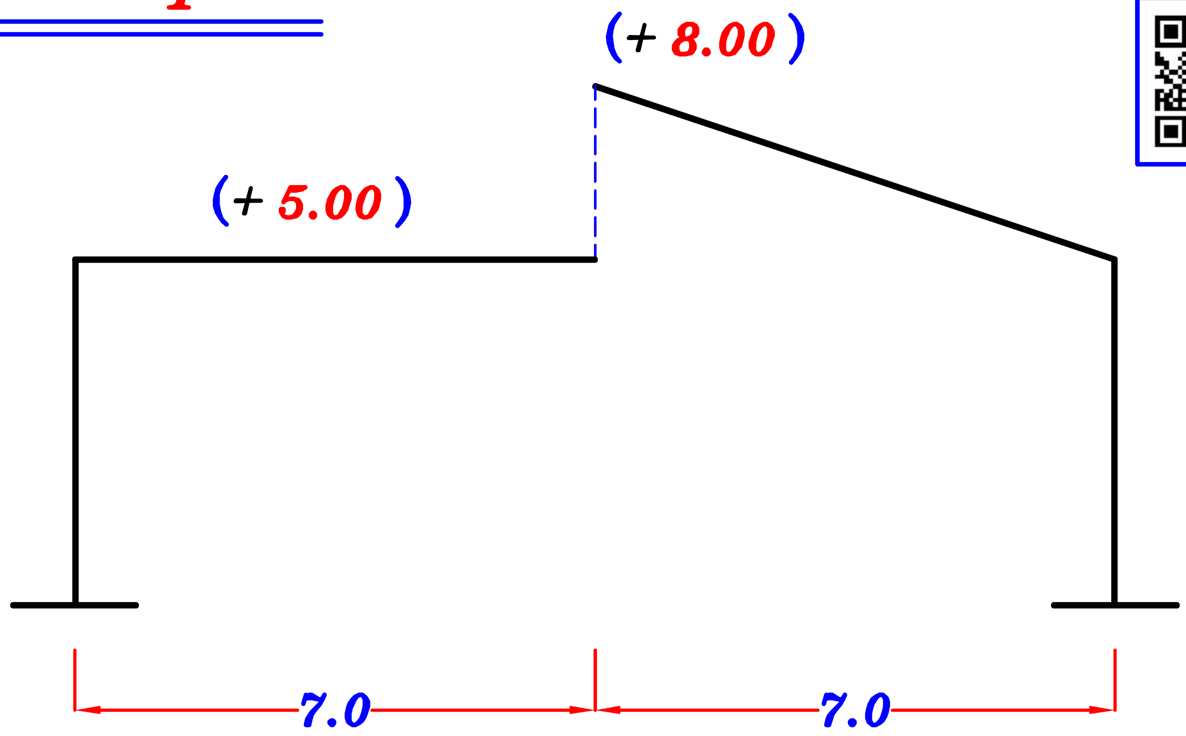
ملحوظه .

اذا كان هناك خيارين ان نحمل الكمرات على ***Post*** او ***Hanger***

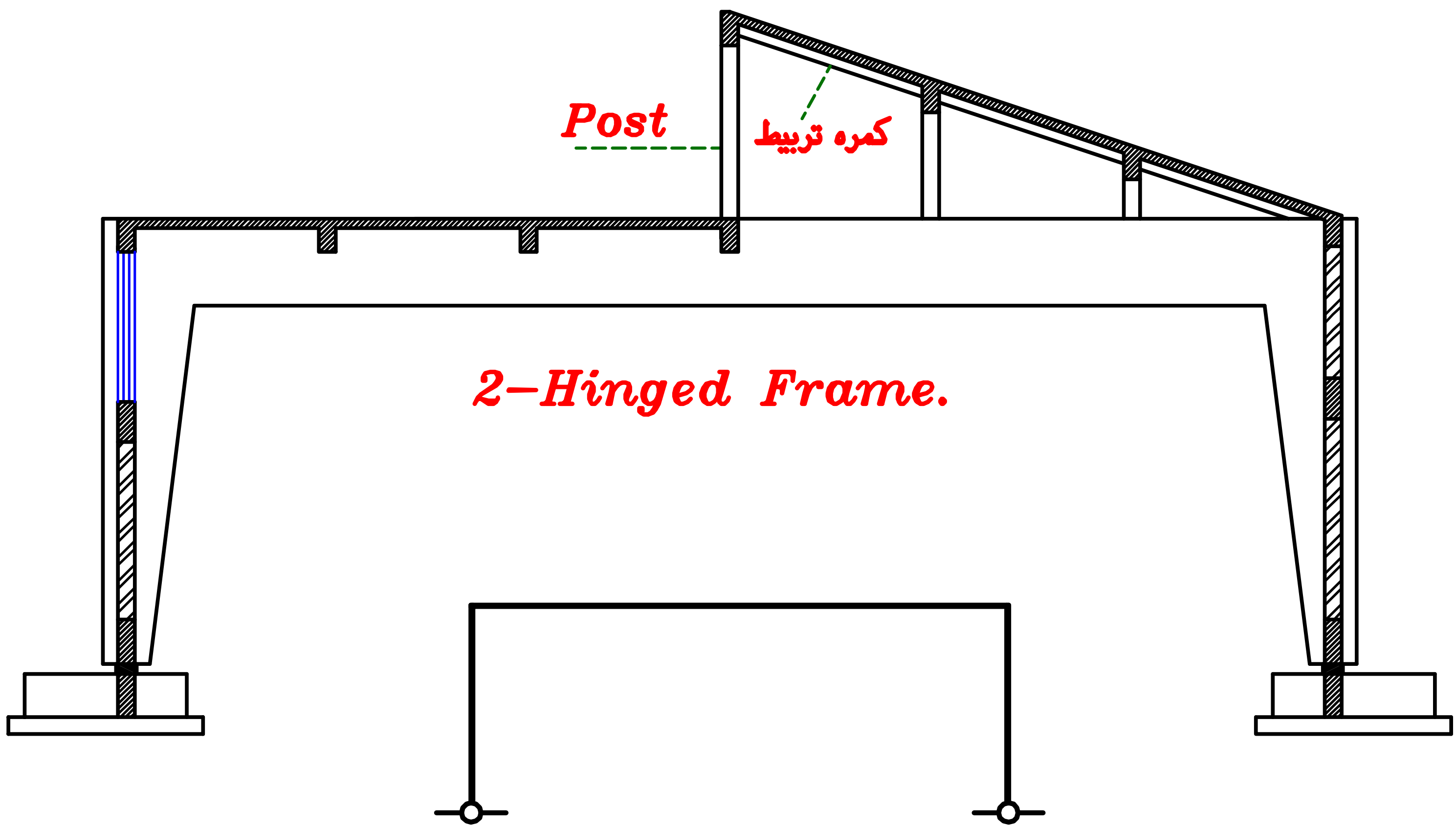
فعاده نفضل استخدام ال ***Post*** الا اذا زاد ارتفاع ال ***Post*** عن ٤,٠ - م

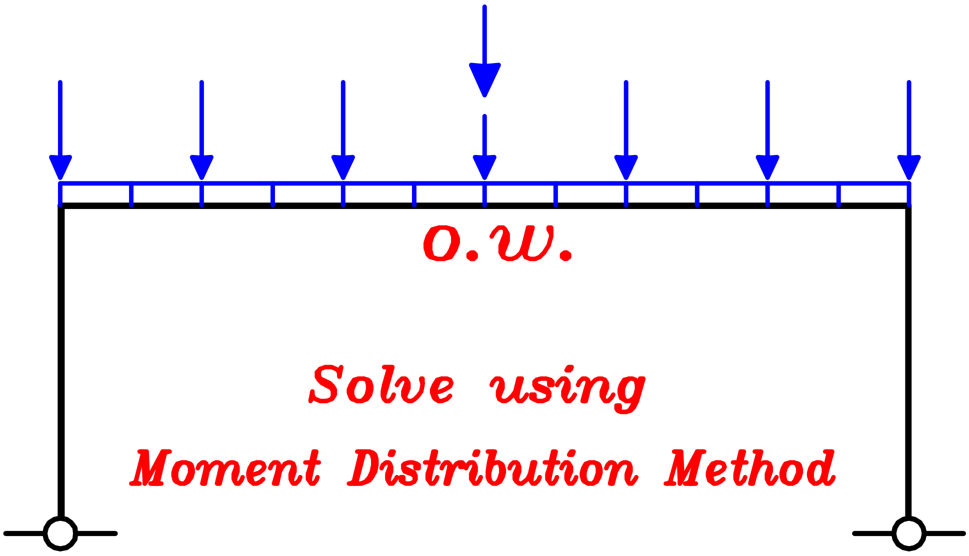
فسيكون استخدام ال ***Hanger*** افضل .

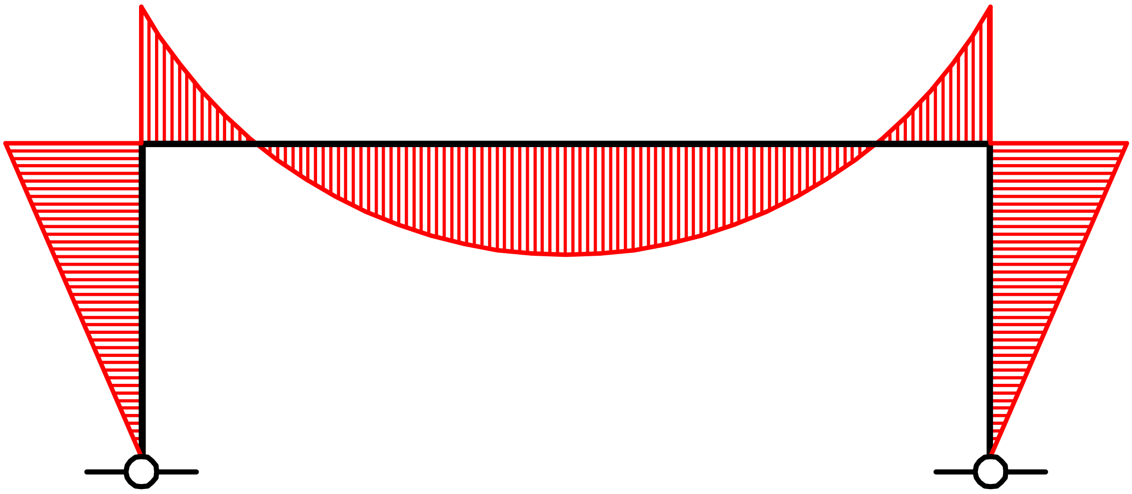
Example.

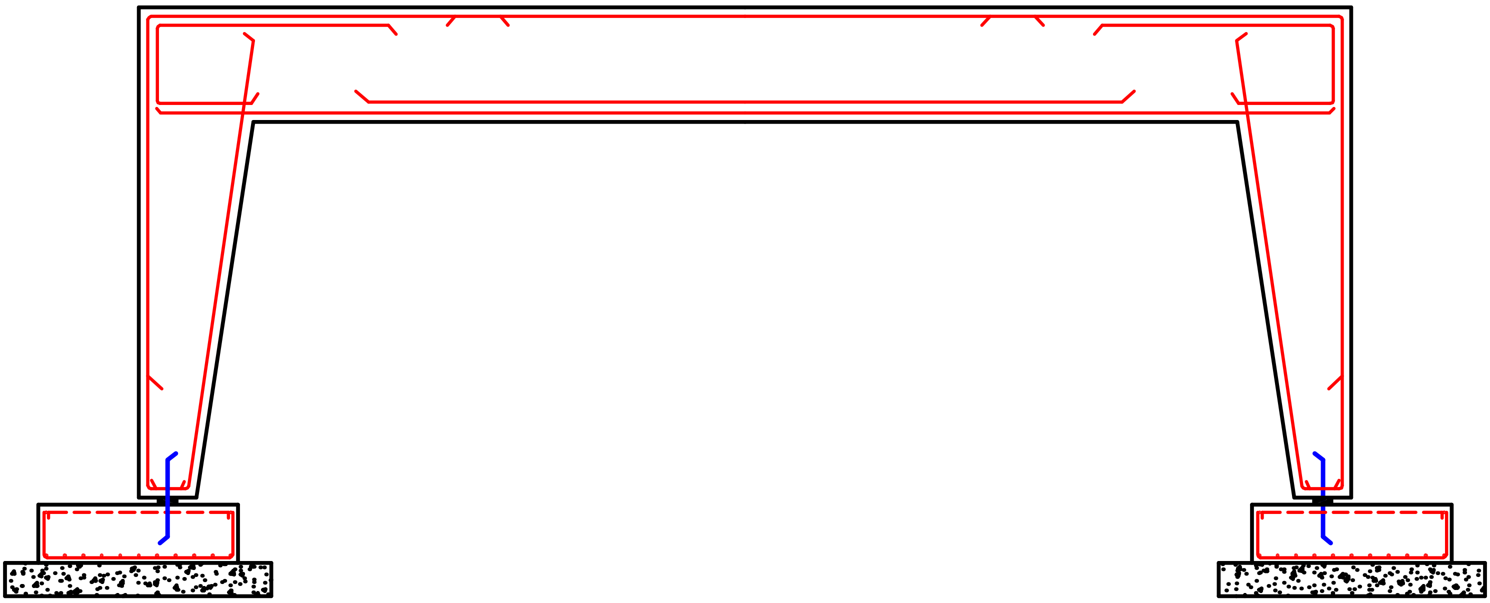


Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions & RFT.

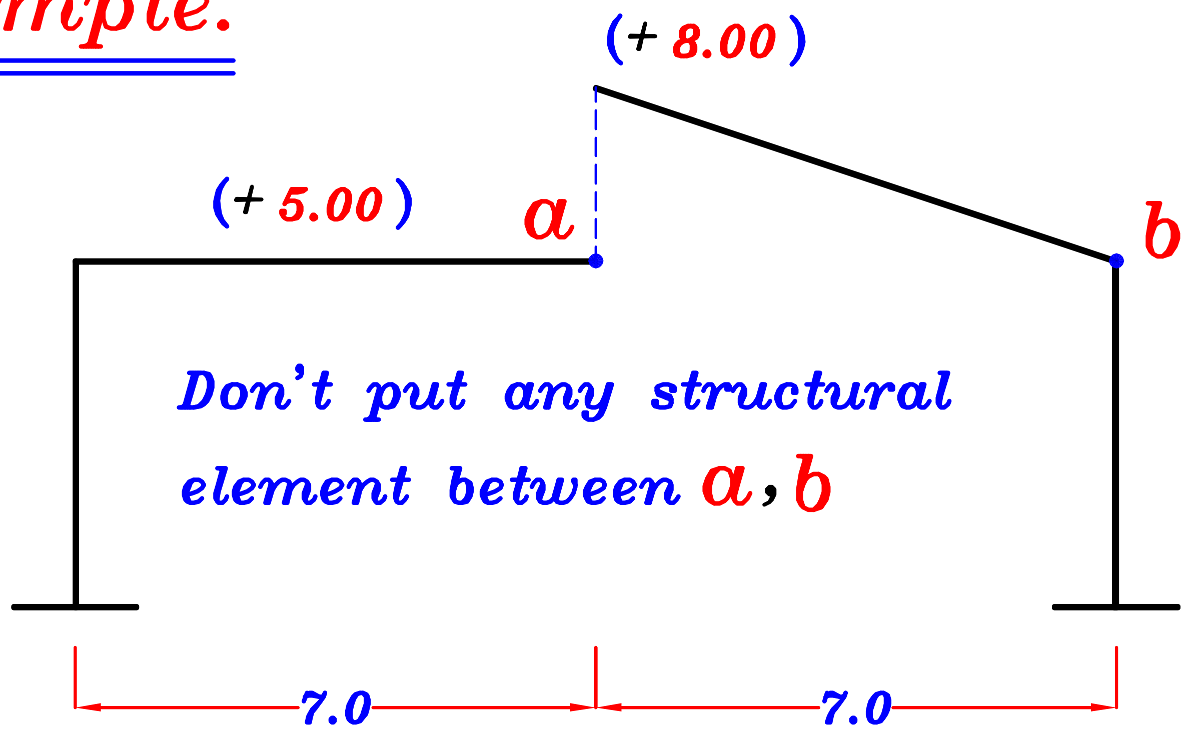



o.w.
Solve using
Moment Distribution Method



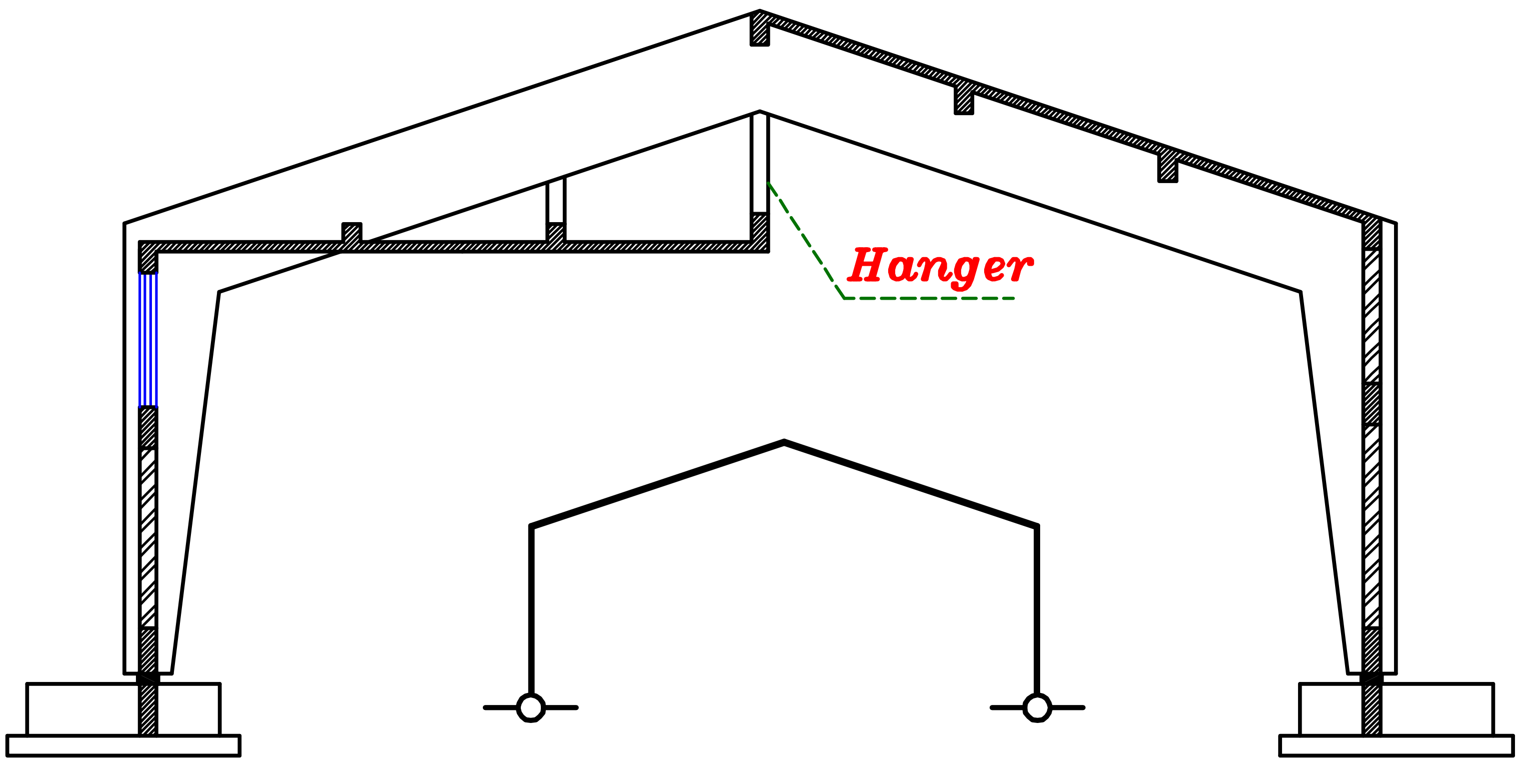


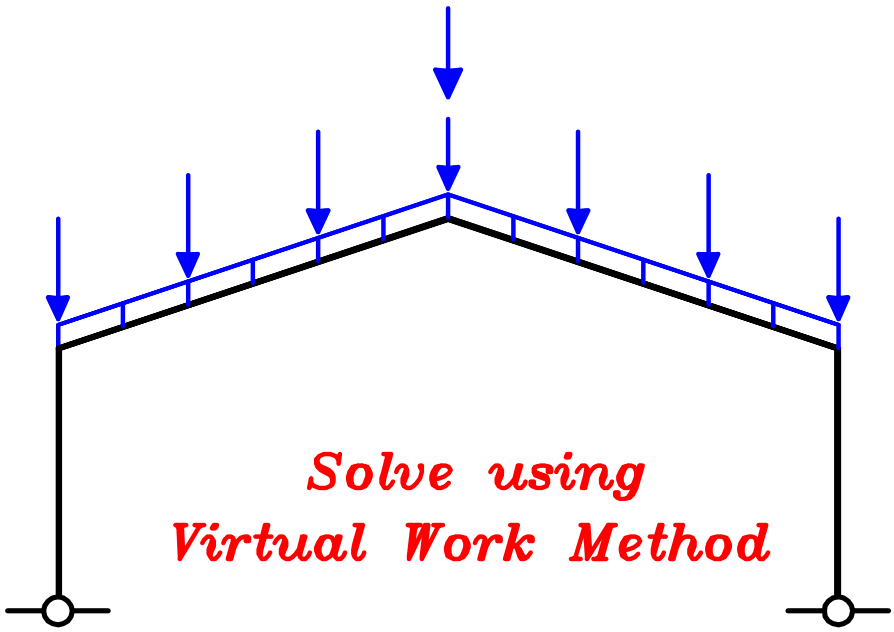
Example.

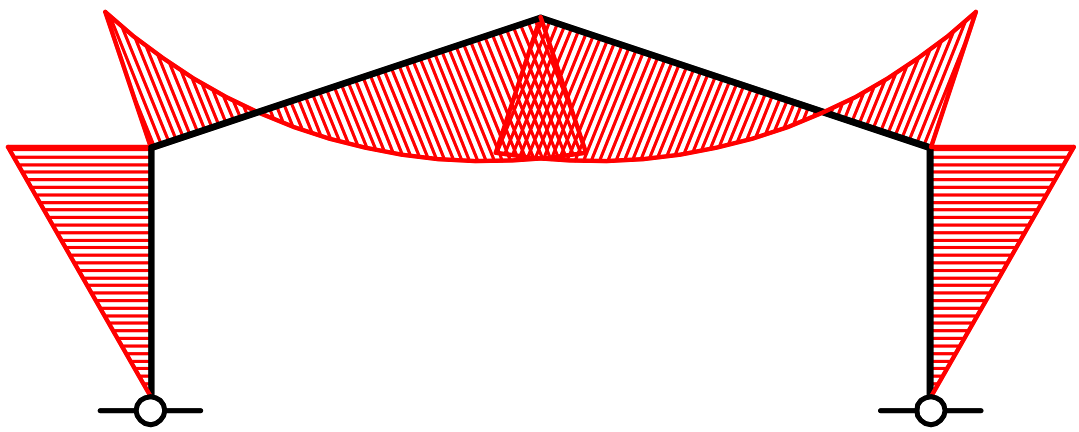


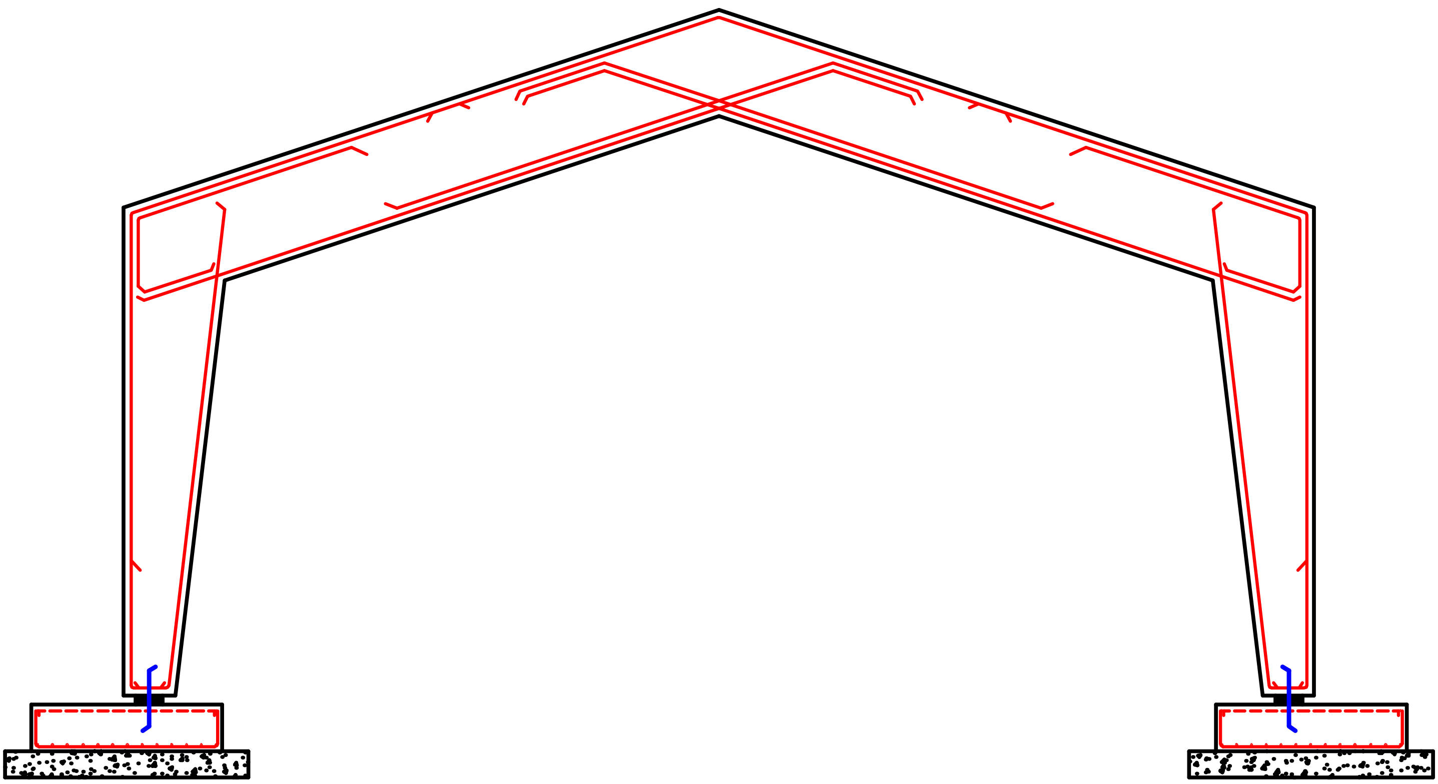
Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions & RFT.

2-Hinged Inclined Frame.

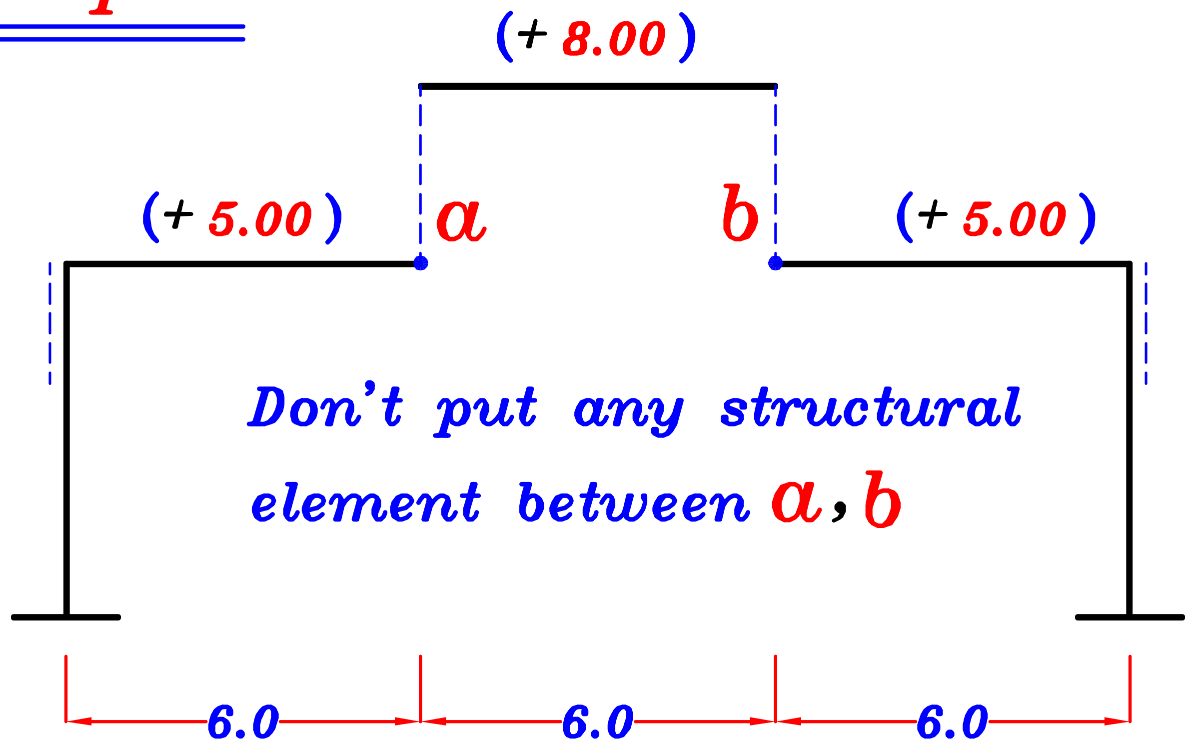



Solve using
Virtual Work Method



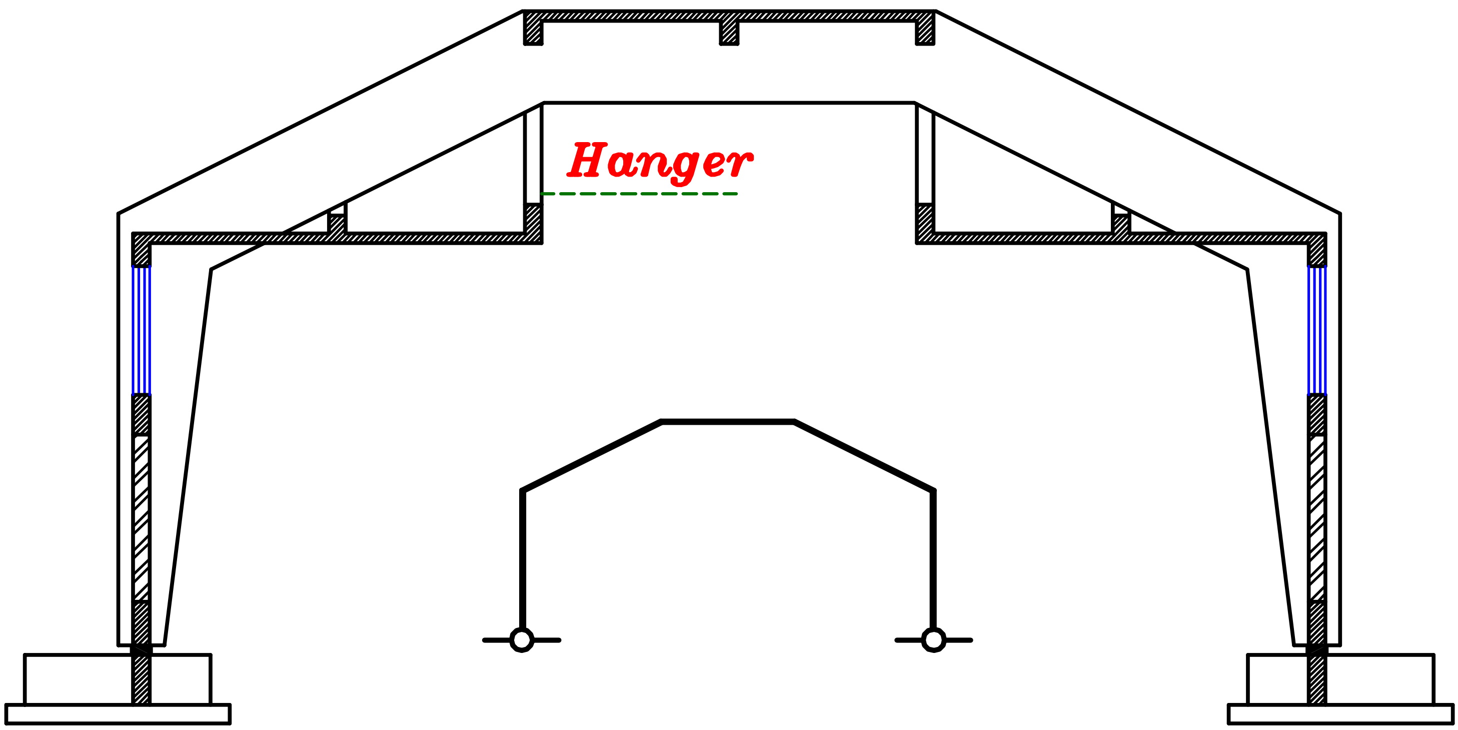


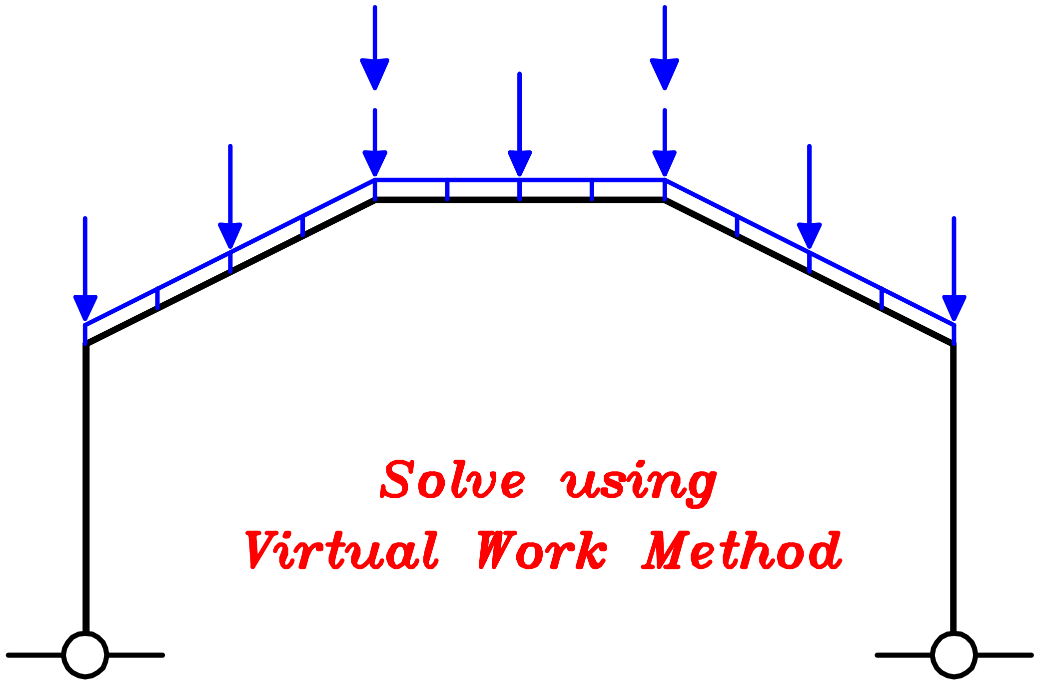
Example.

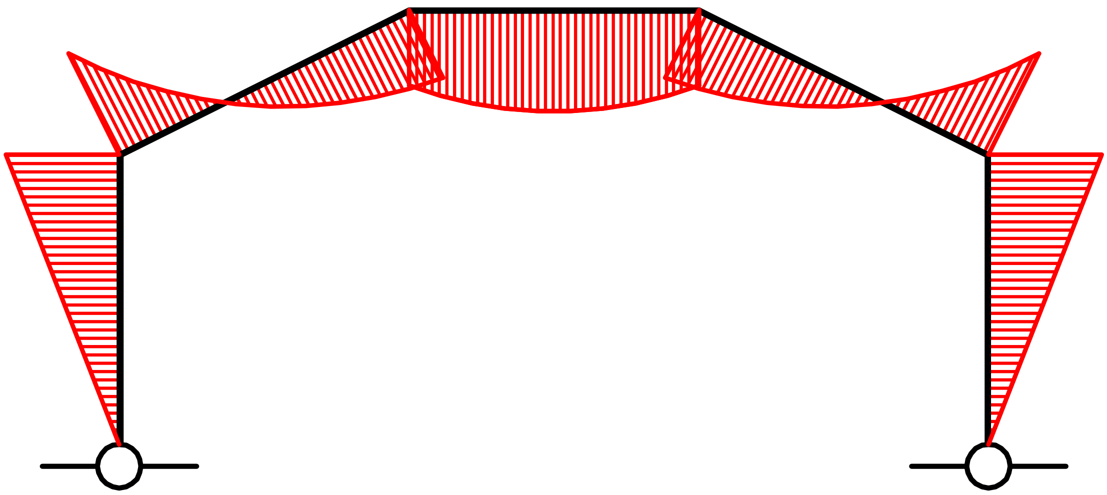


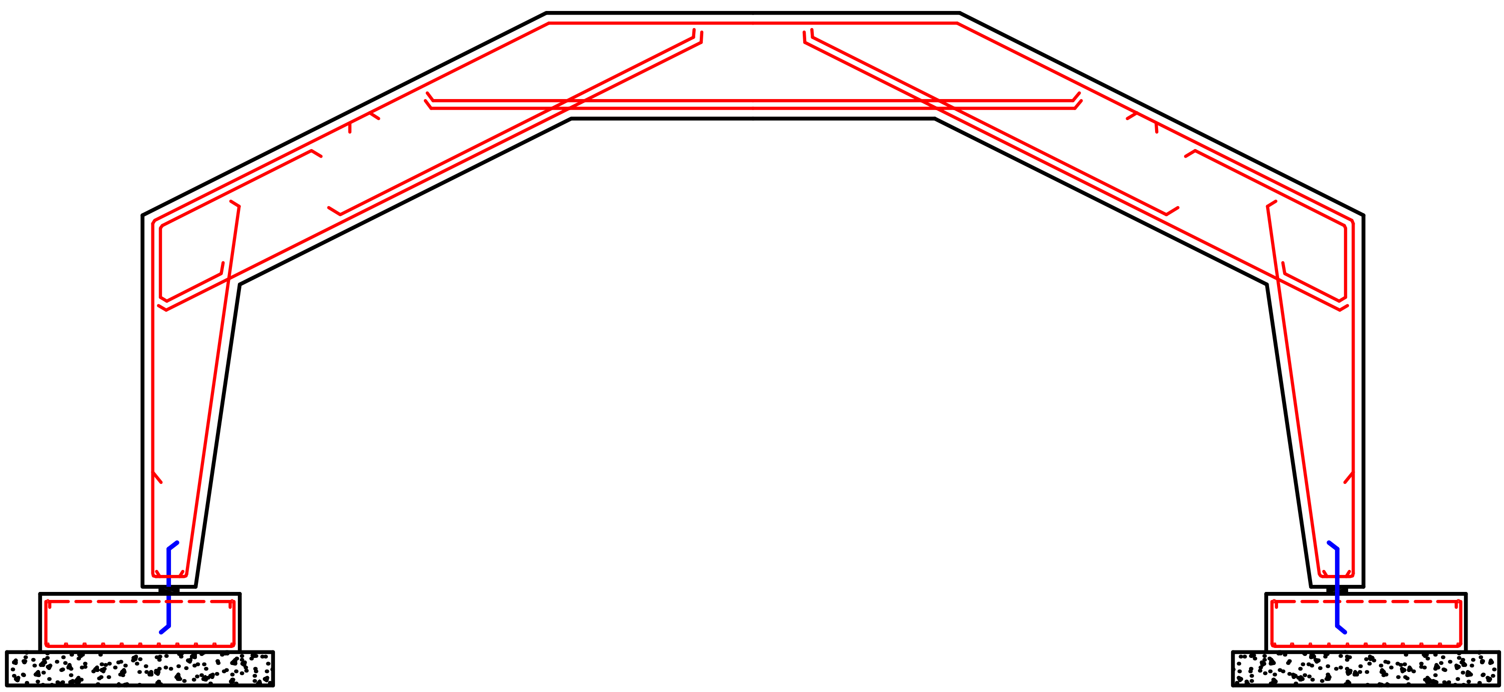
Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions & RFT.

2-Hinged Inclined Frame.

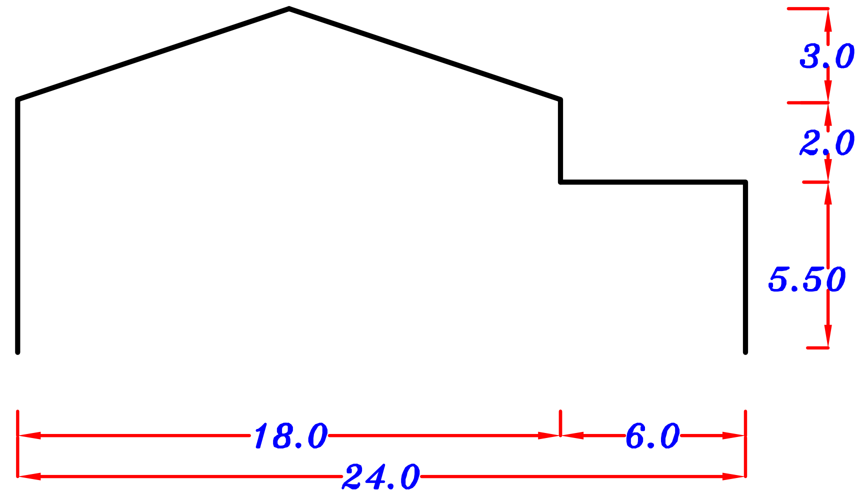



Solve using
Virtual Work Method

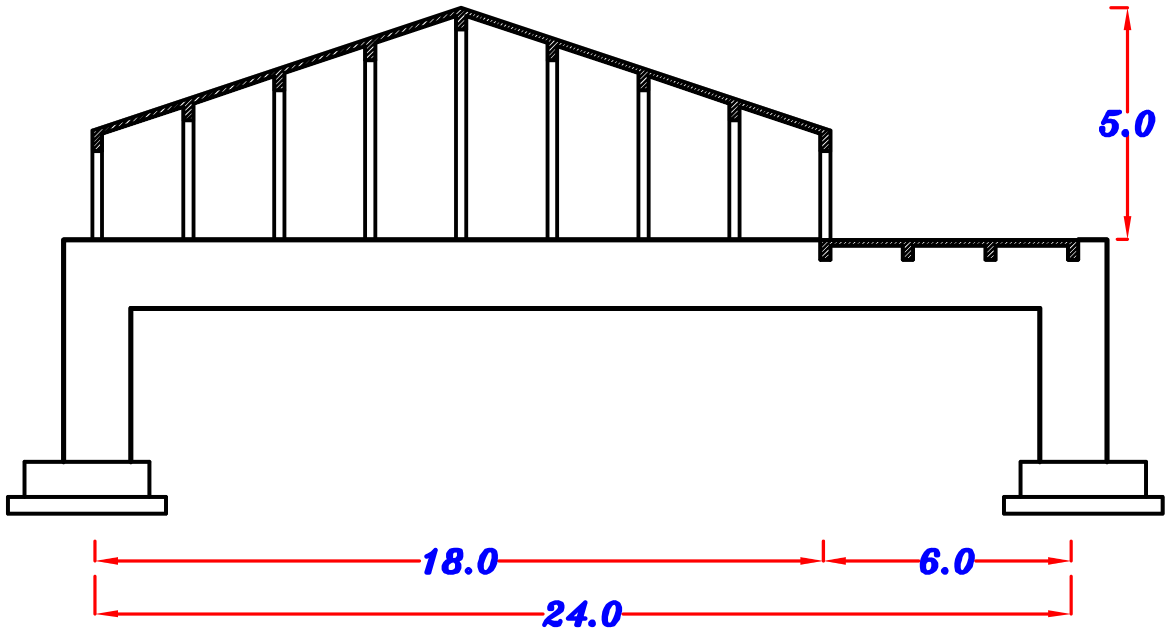




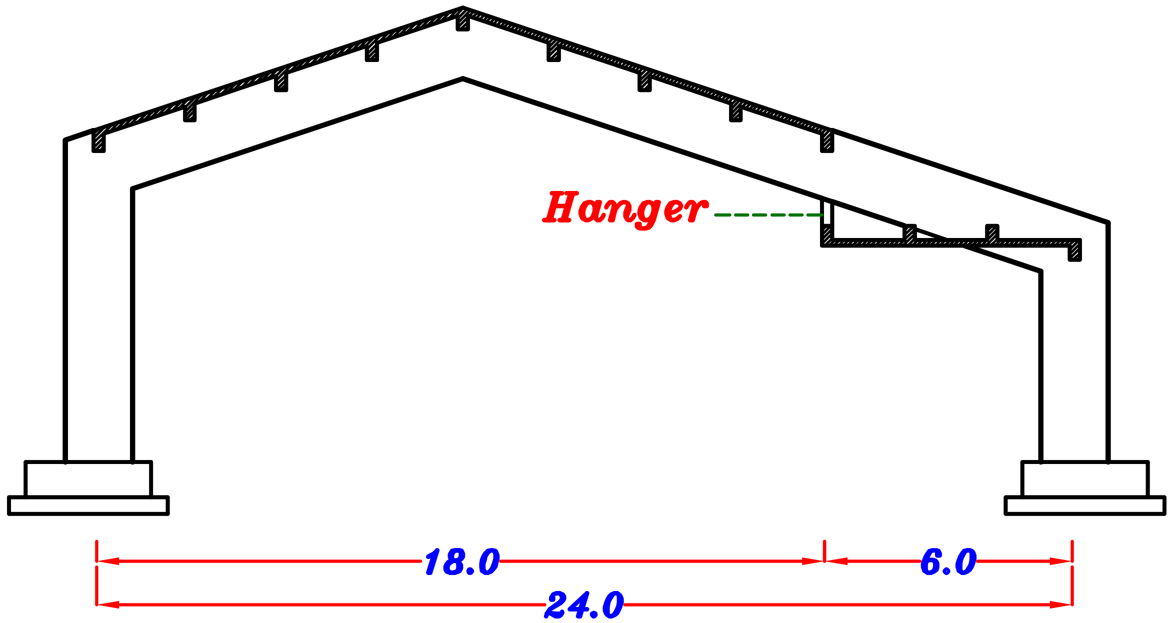
Note.



اذا اخترنا البلاطه محموله على **post** و ال **post** محمول على **Frame** أفقى
فى هذه الحاله سيوجد **post** ارتفاعه ٥,- م و هذا بالطبع حل سيىء و لكن ليس خطأ .

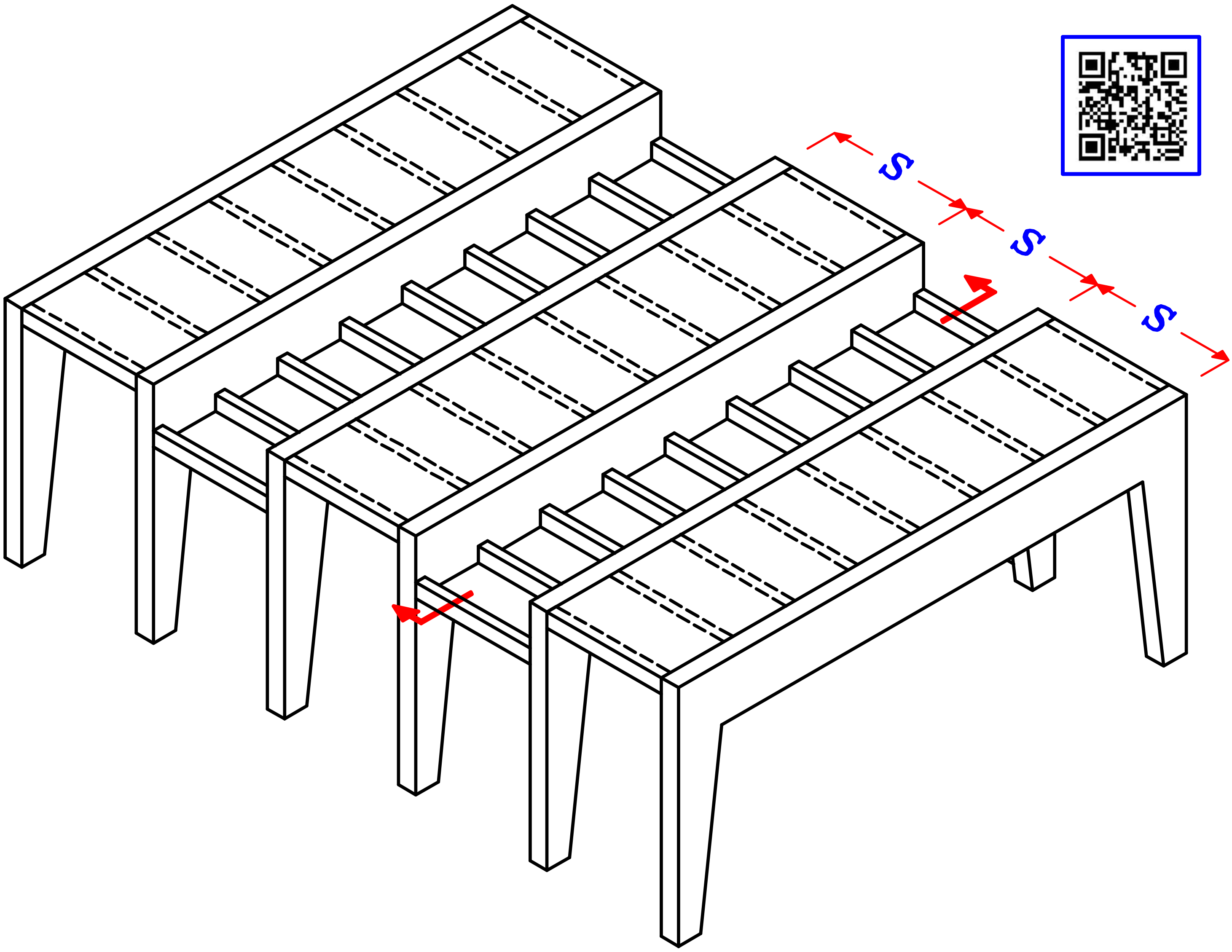


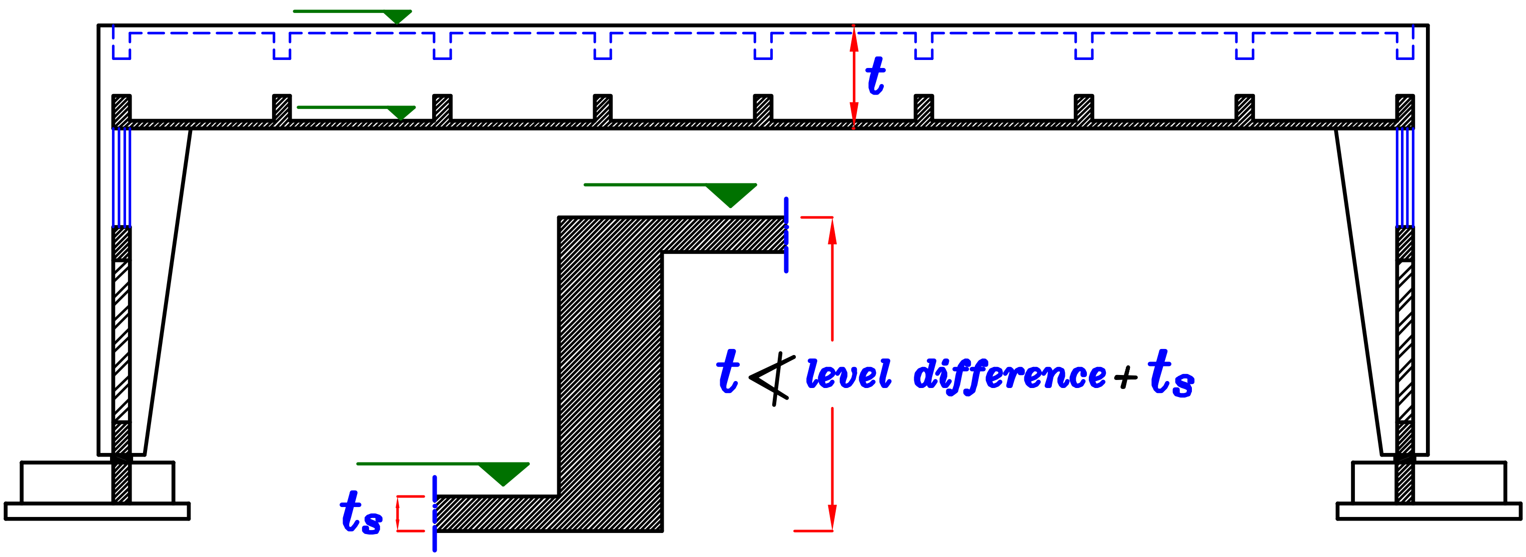
يفضل جعل البلاطه الافقيه محموله على **Hanger**



Note.

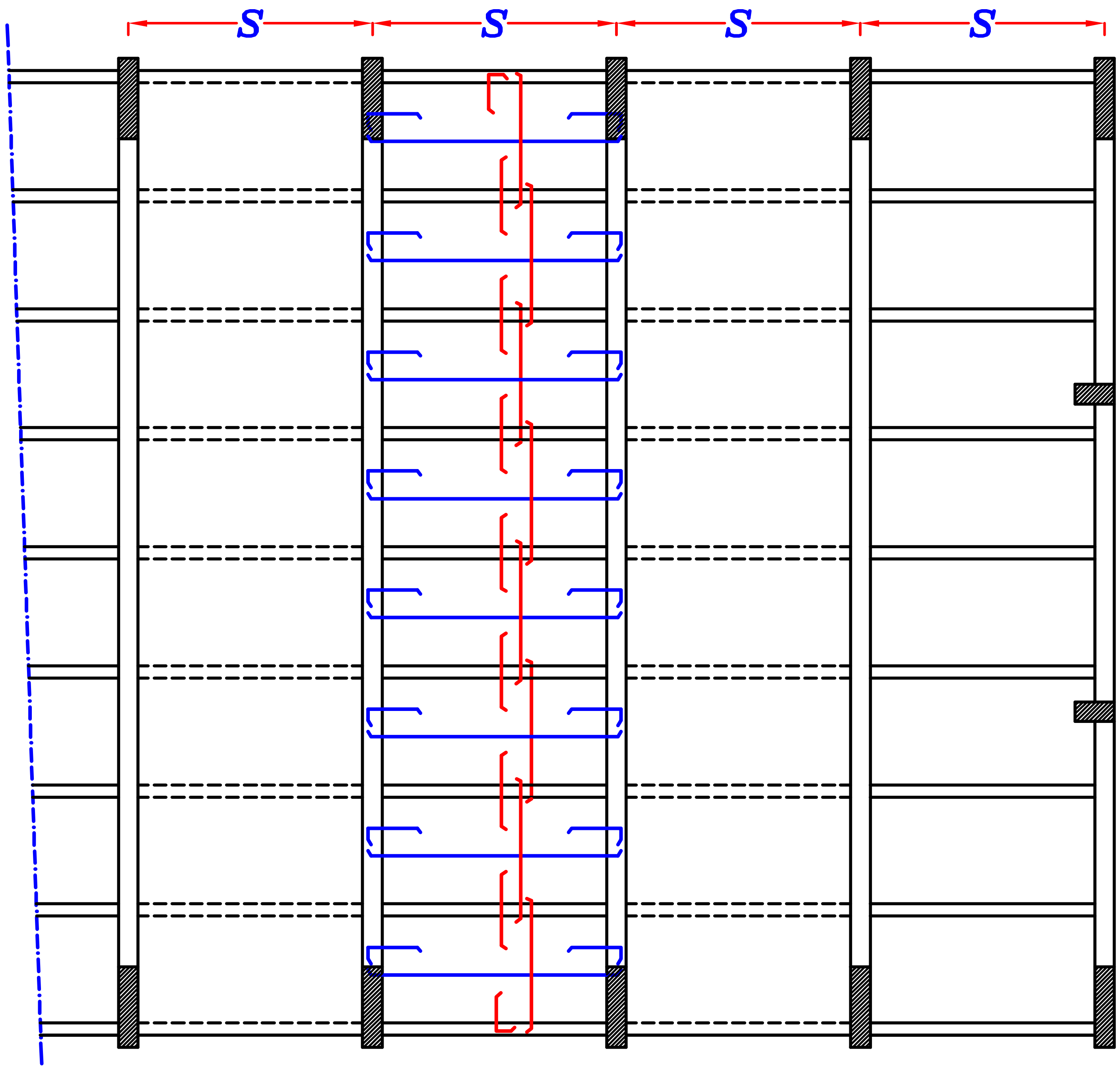
اذا كان ال **Frame** يحمل مباشره بلاطات فى منسوبين مختلفين
فيفضل الا يزيد فق المنسوب بينهم عن ٢,٠ م حتى لا نضطر لعمل عمق كبير جدا لل **Frame**
مما يعمل على زياده التكلفه .
فى بلاطات المنسوب الاقل يفضل أن تؤخذ كمرات مقلوبه حتى لا نعمل على زياده عمق ال **Frame**



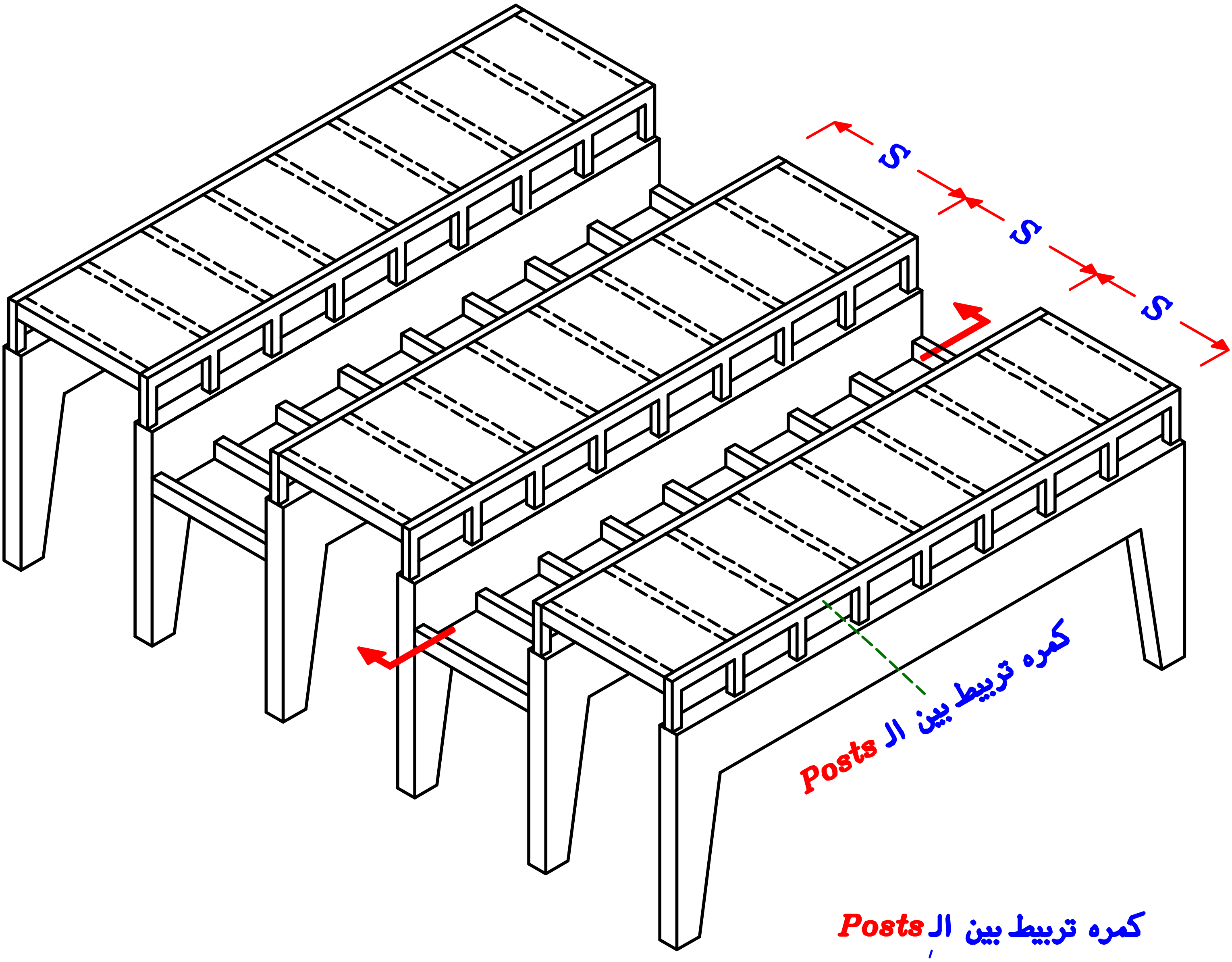


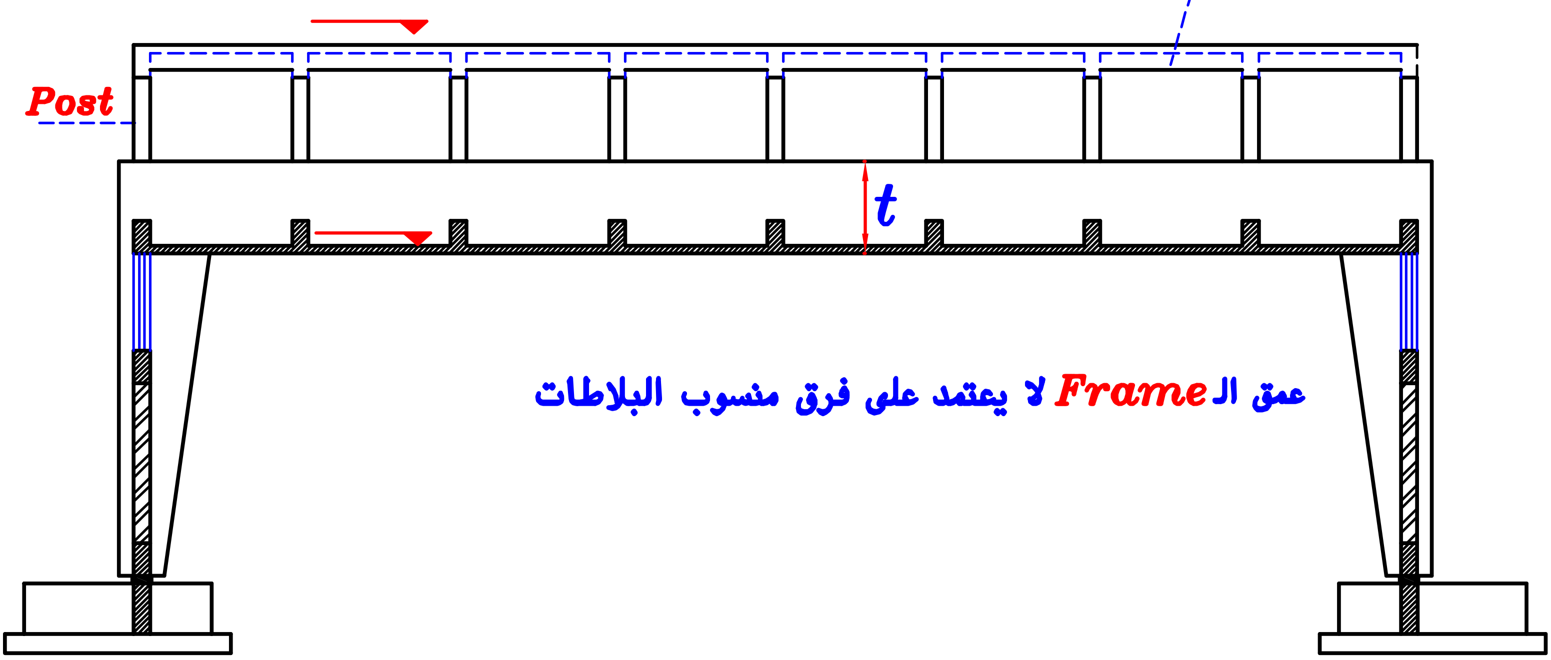
عمق ال **Frame** لا يقل عن فرق المنسوب بين البلاطتين مضاف اليه تخانه البلاطه السفليه .

RFT. of the slab.

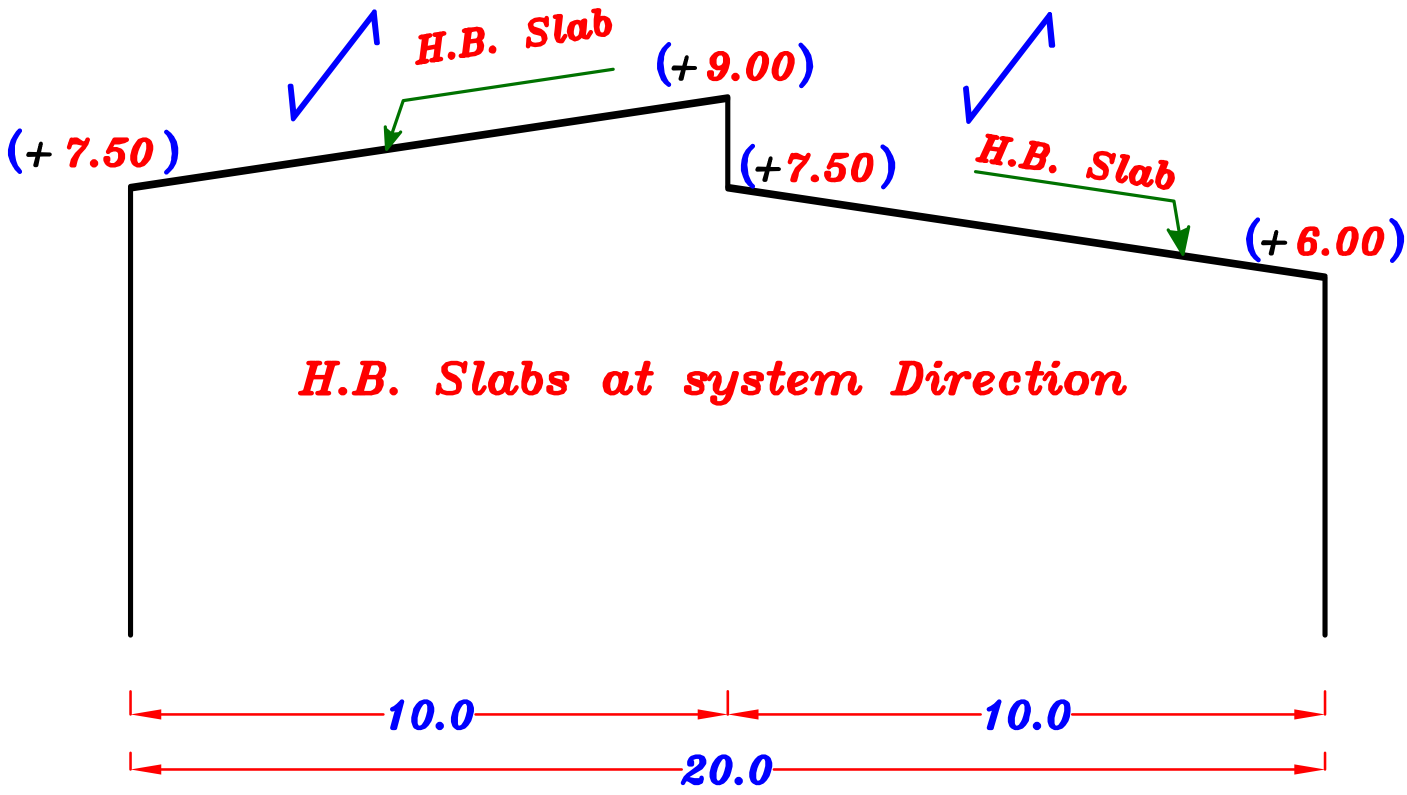


اما اذا زاد الفرق فى المنسوب بين البلاطتين عن ٢,٠ م
فيفضل ان يحمل الـ Frame بلاطه منهم مباشره و الاخرى
تحمل اما على Posts أو على Hangers

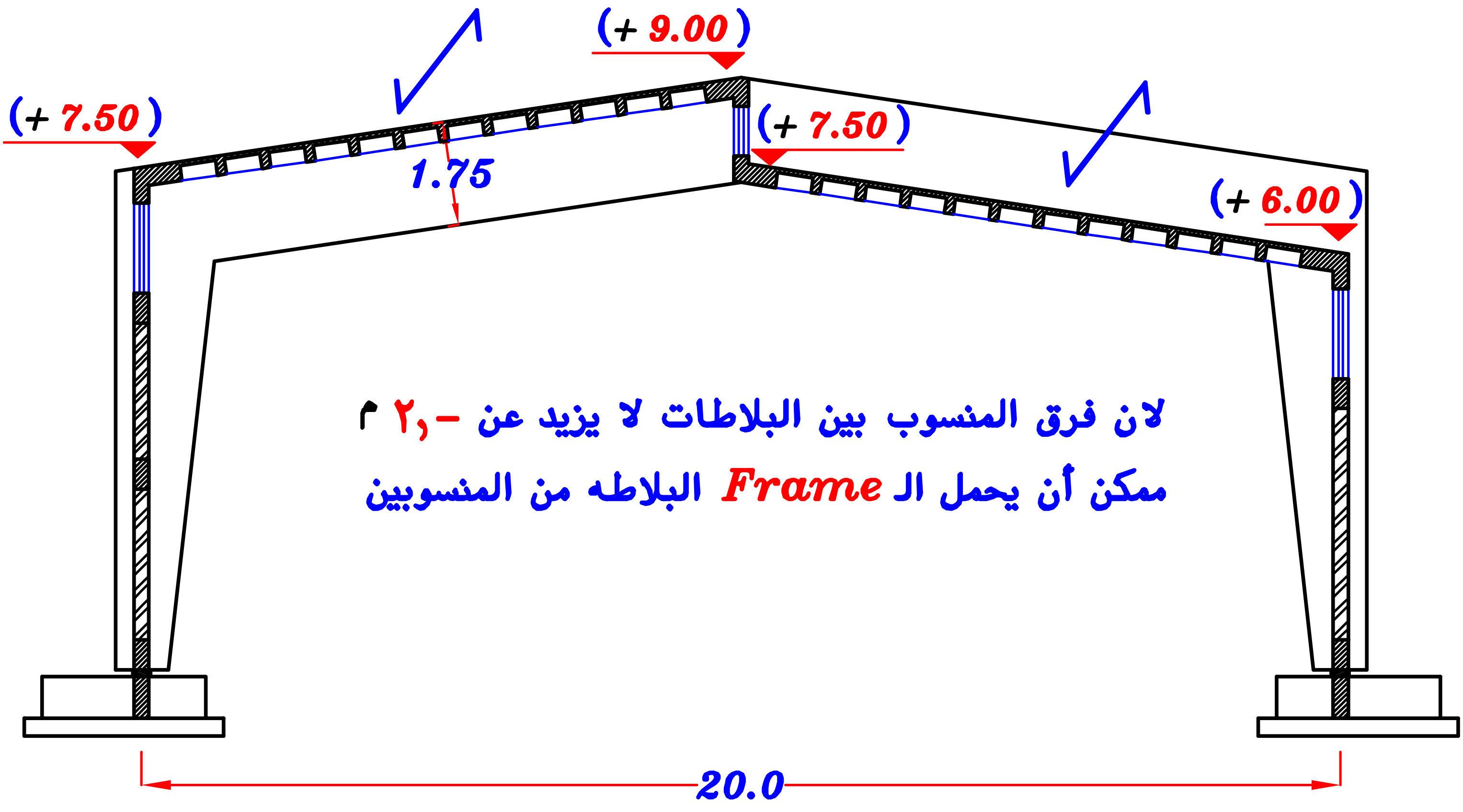




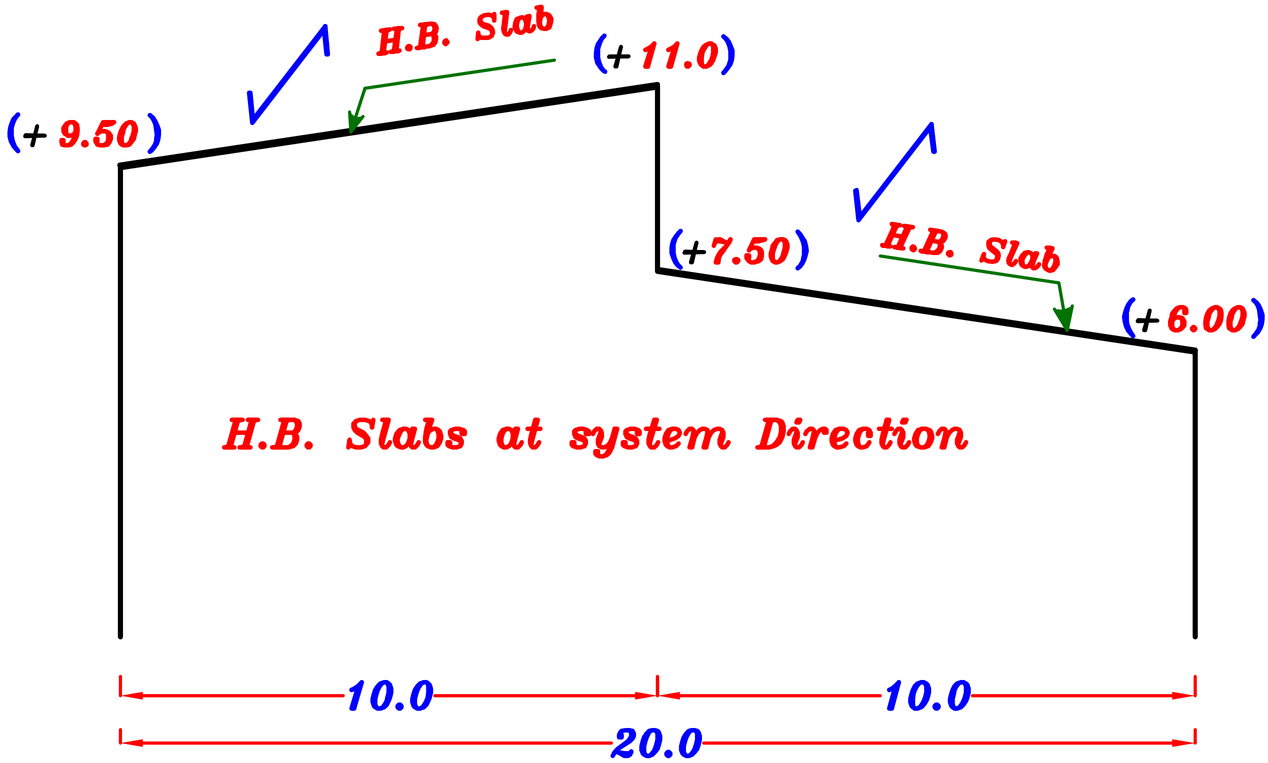
Example.



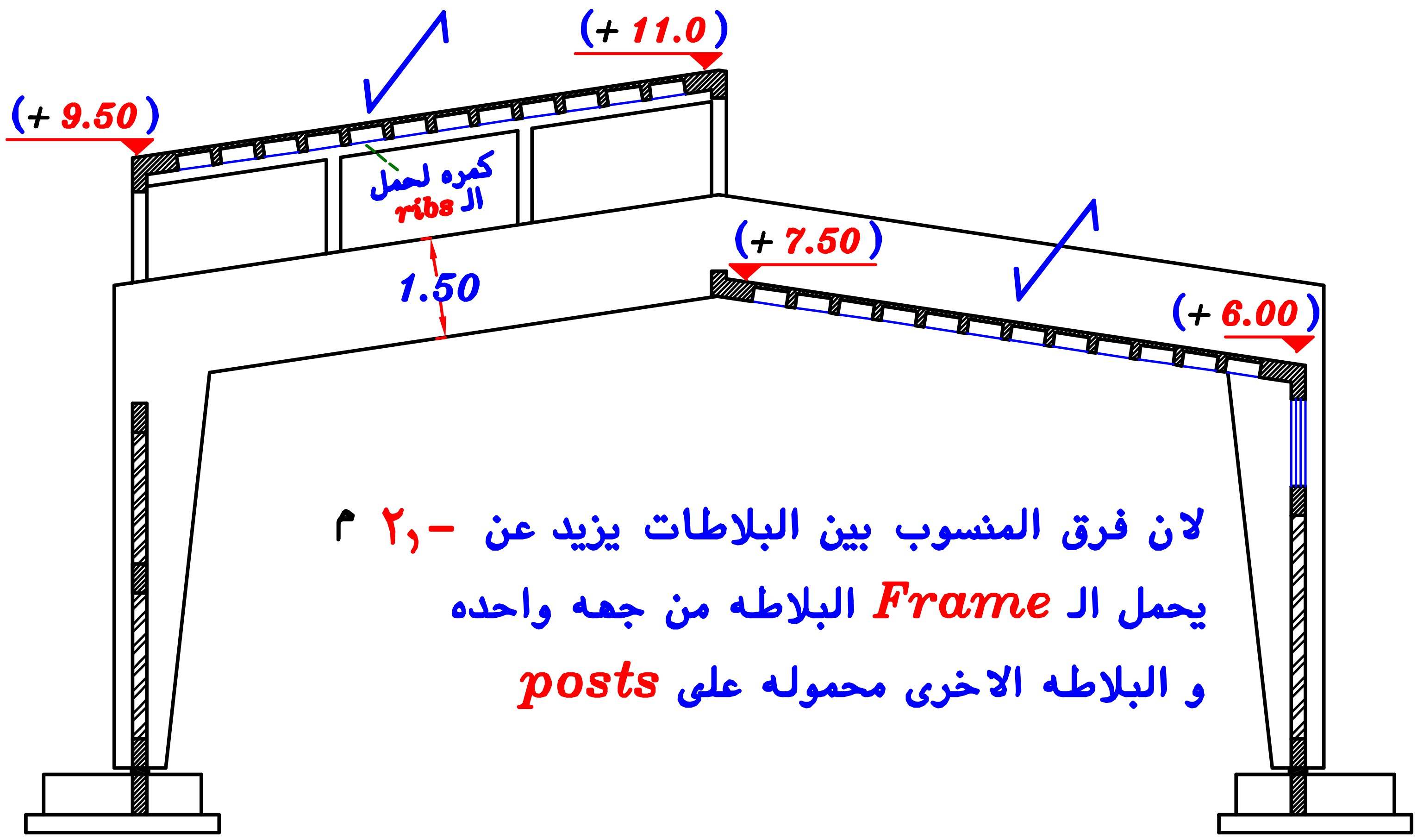
Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.



Example.



Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

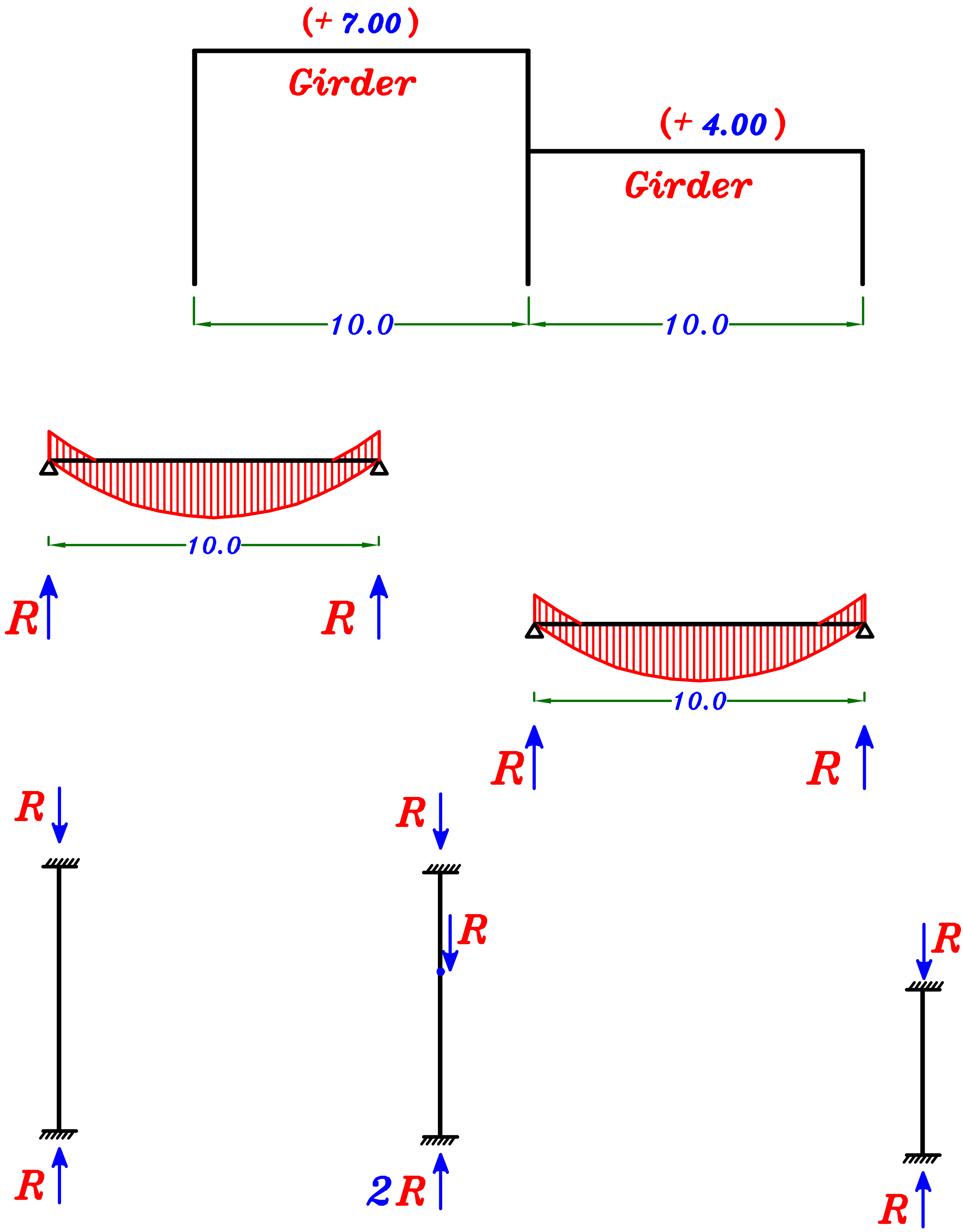


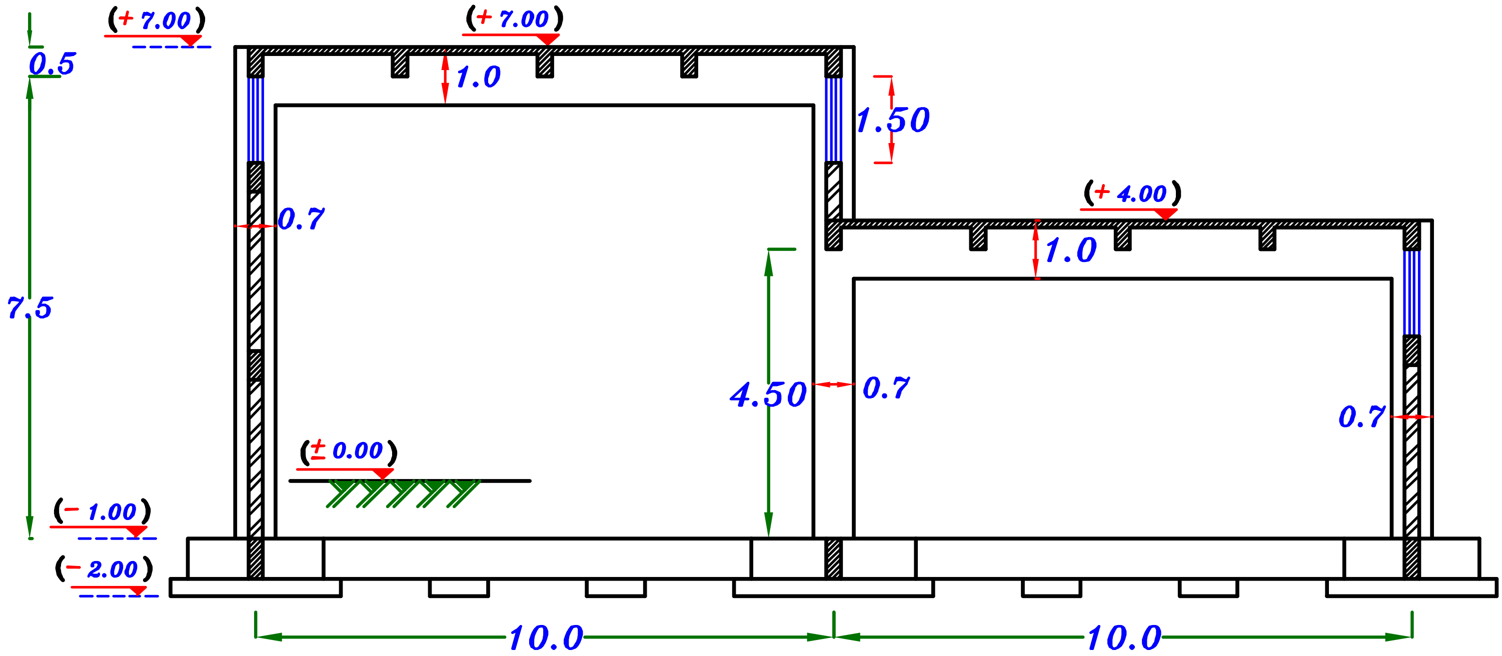
لان فرق المنسوب بين البلاطات يزيد عن ٢,٠ م

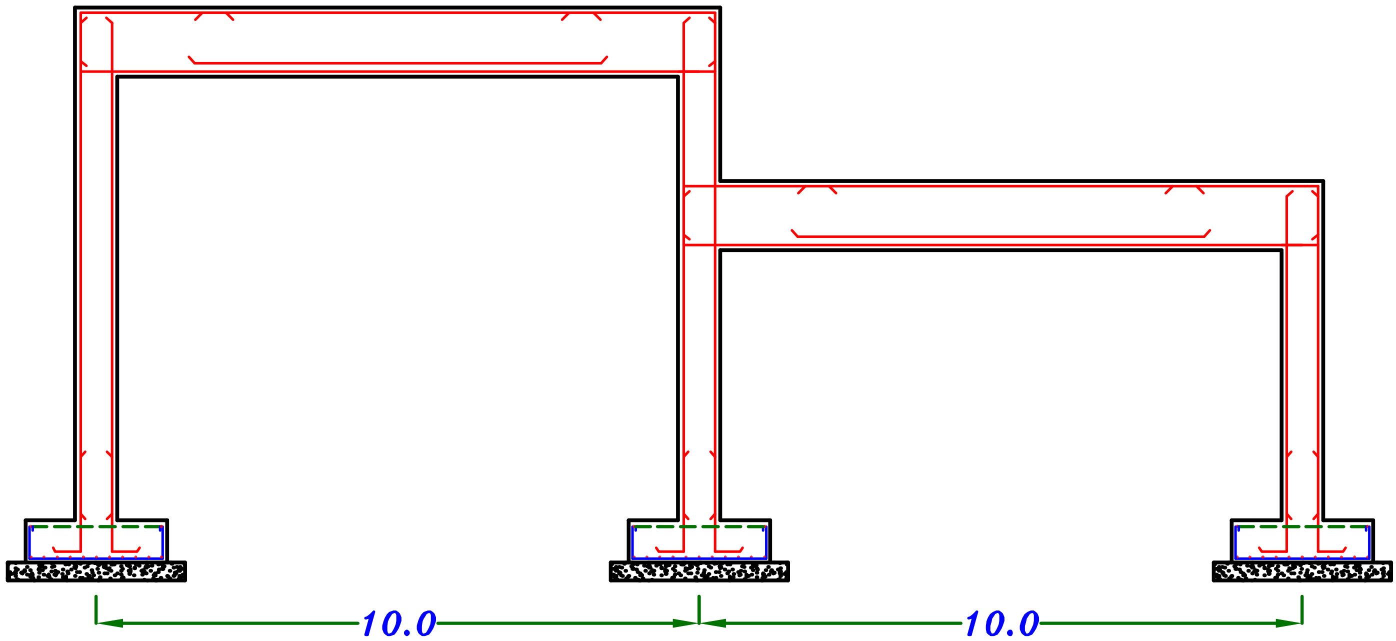
يحمل الـ Frame البلاطه من جهه واحده

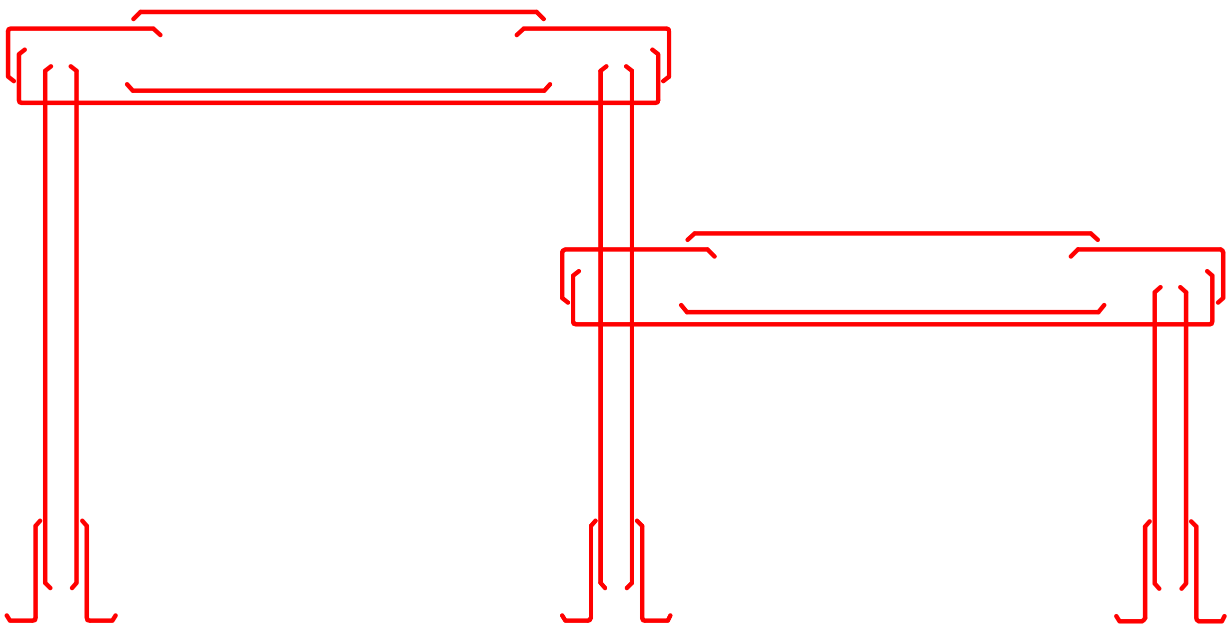
و البلاطه الاخرى محموله على posts

Connection between two Girders.

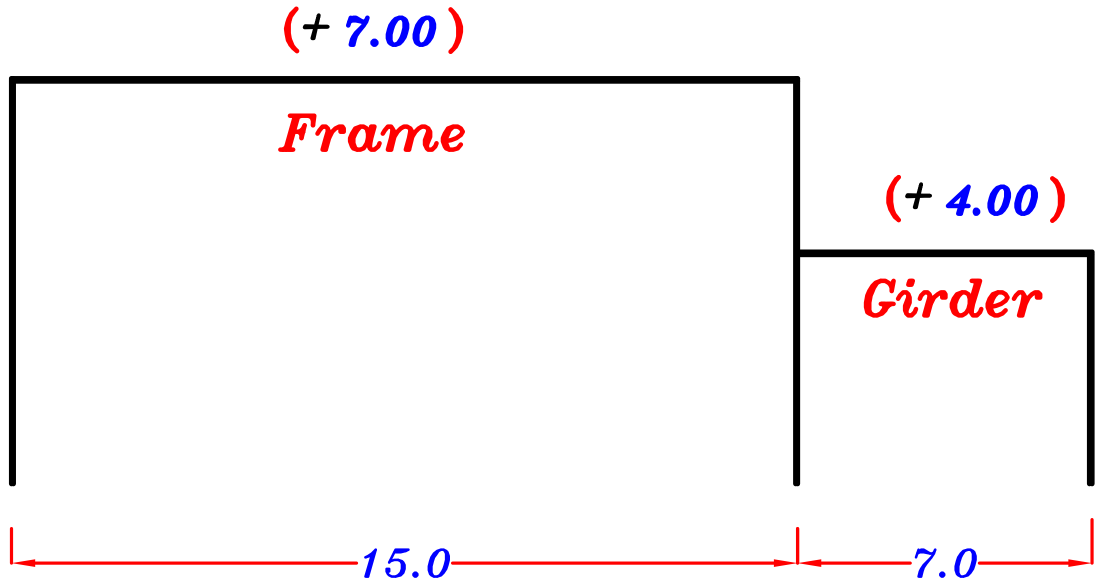


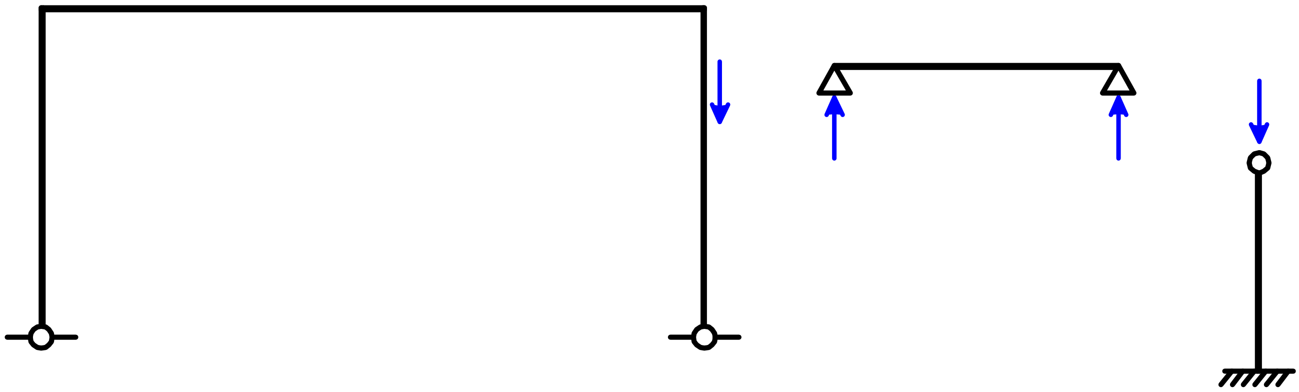

(+ 7.00)
(+ 7.00)
0.5
1.0
1.50
7.5
0.7
(+ 4.00)
1.0
4.50
0.7
0.7
(± 0.00)
(− 1.00)
(− 2.00)
10.0
10.0

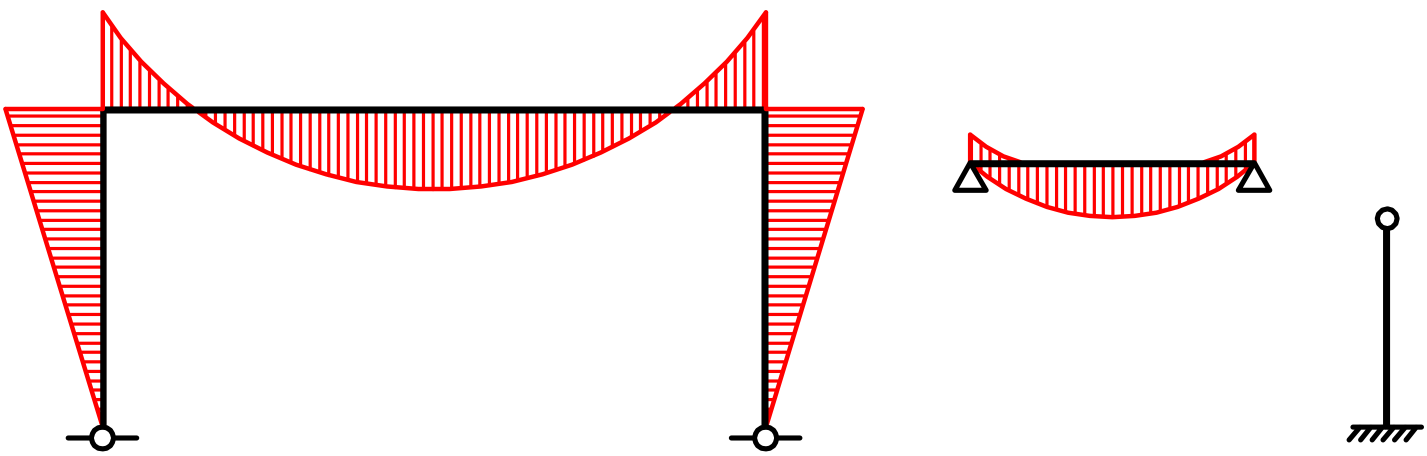

10.0
10.0



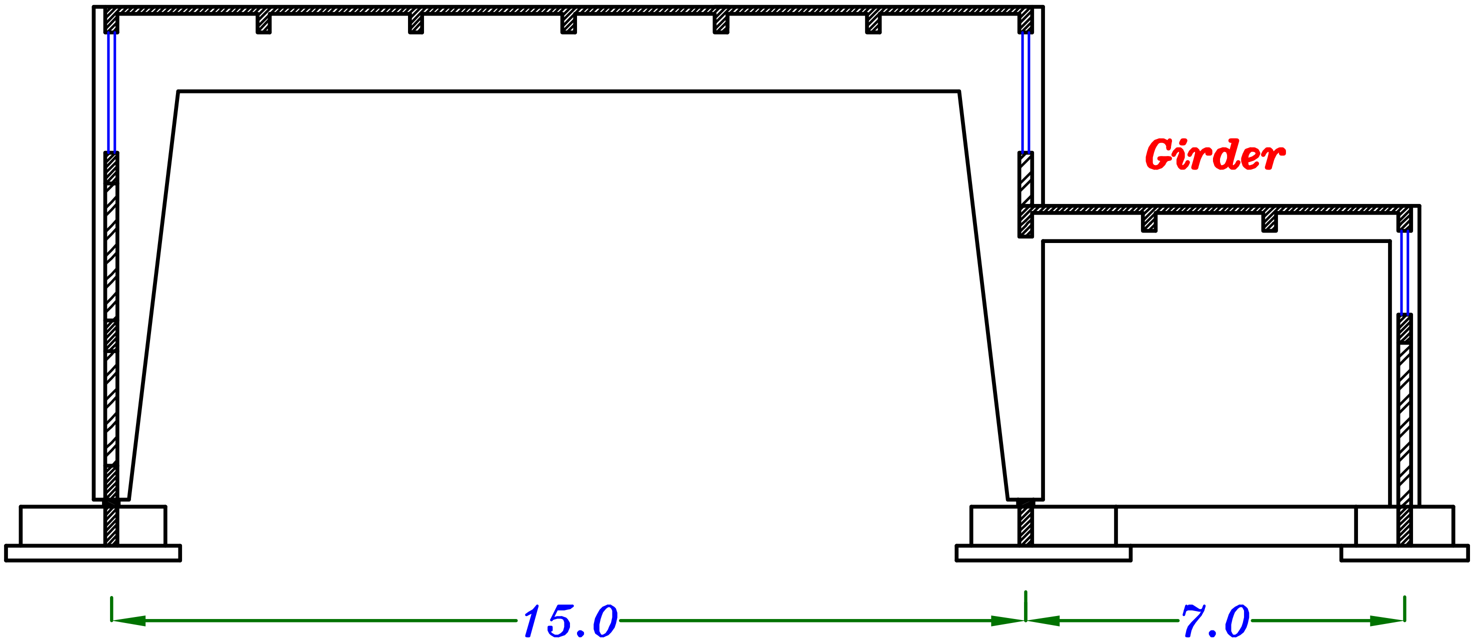
Connection between Girder & Frame.

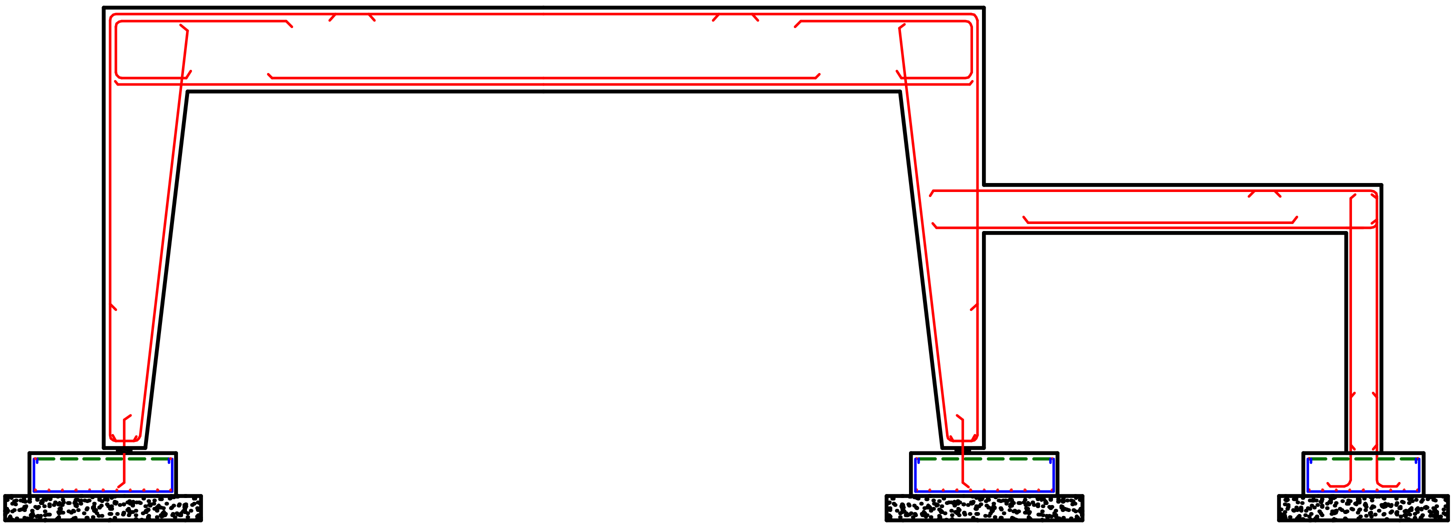


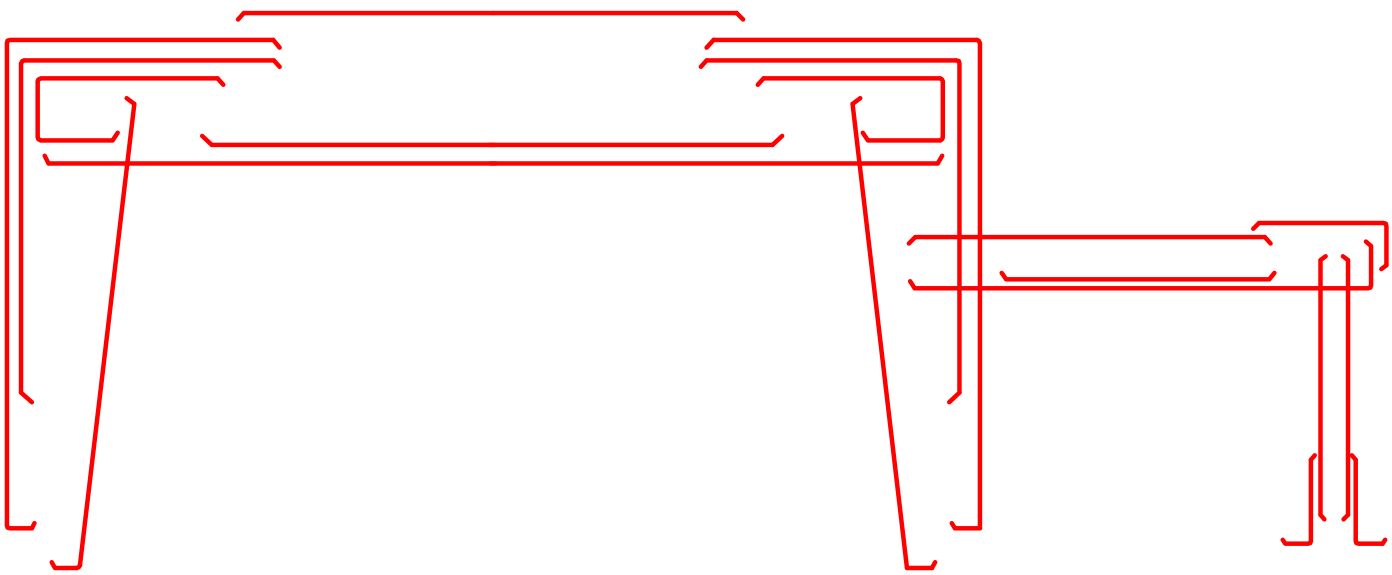




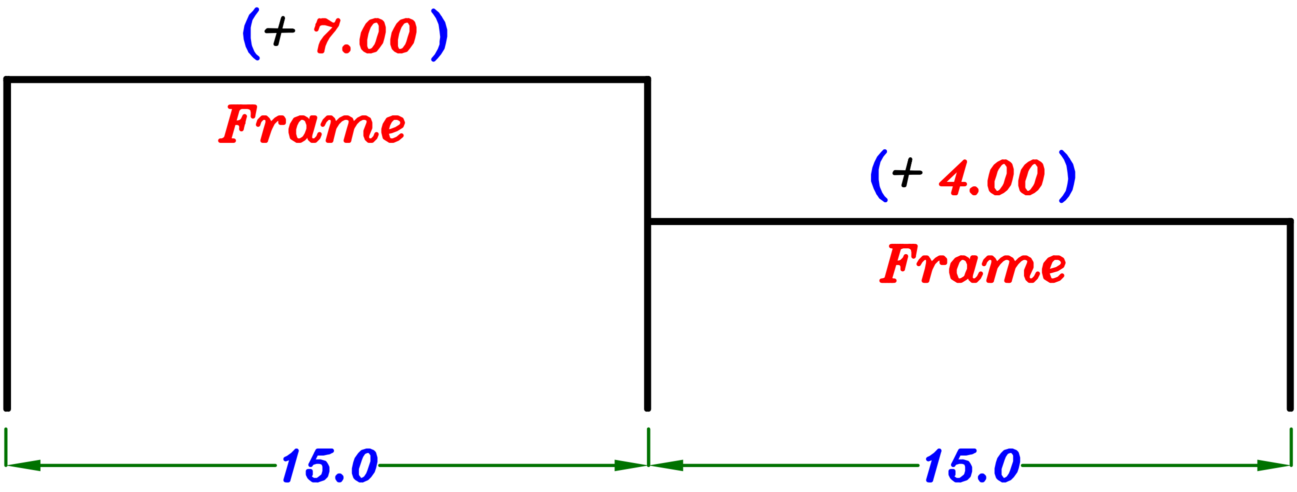
Two-Higed Frame



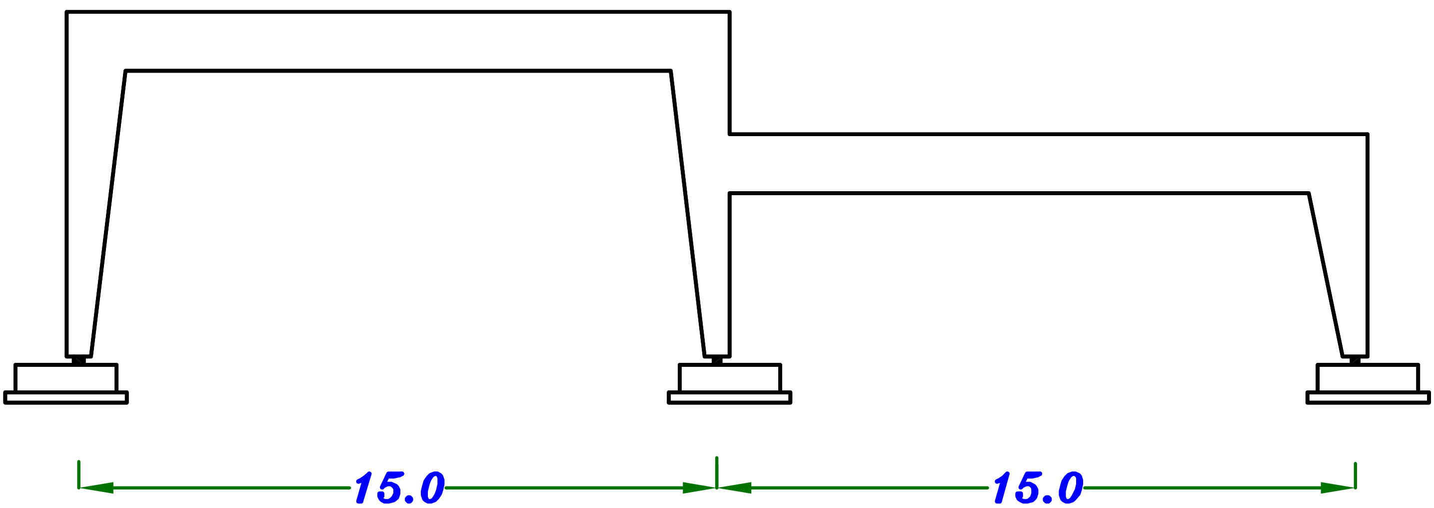


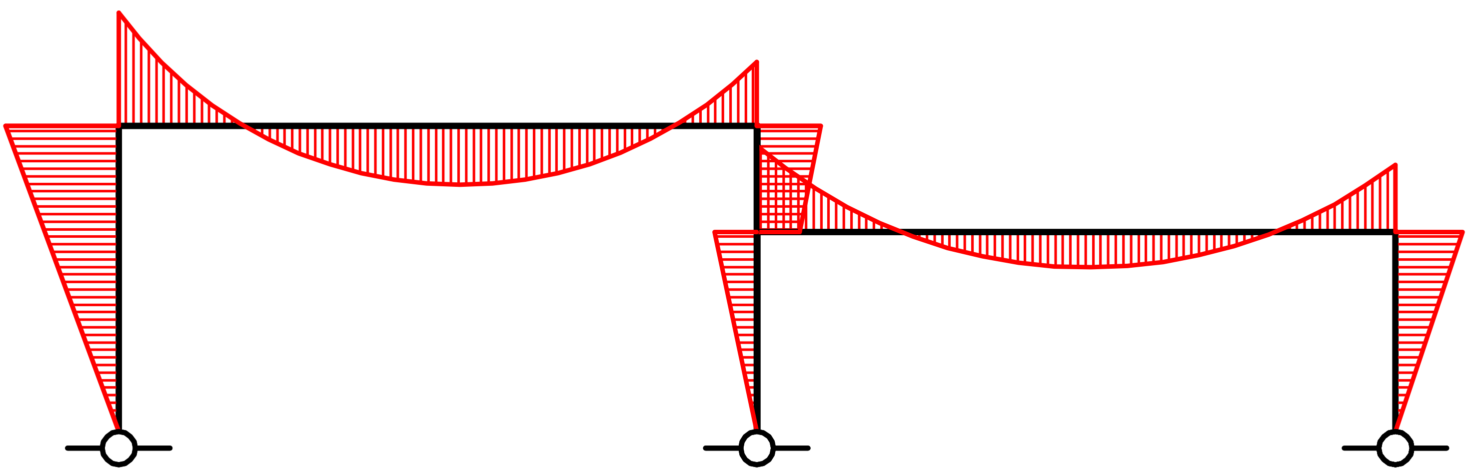


Connection between two Frames.



عاده في العمل يحل هذا ال ***system*** على انه ***Continuous Frame***

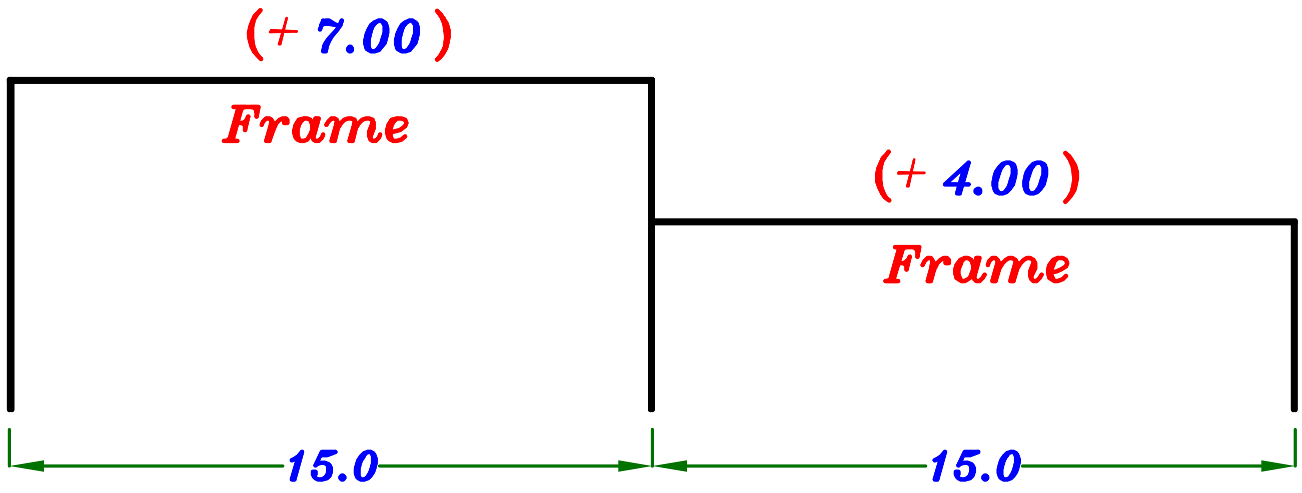




لكن حله يدويا سيكون صعب جدا

لذا يفضل فى الدراسه ان نفصل بينهم و نحل كل ***system*** بمفرده .

يفضل فى الدراسه ان نفصل بينهم و نحل كل system بمفرده .



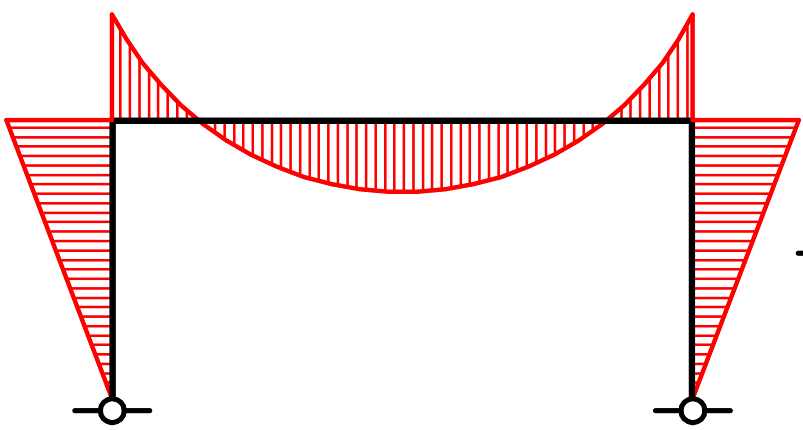
يفضل أن نفصل بين ال 2 Frames

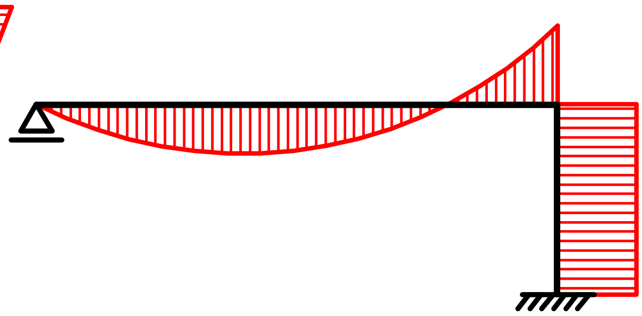
Two Hinged Frame

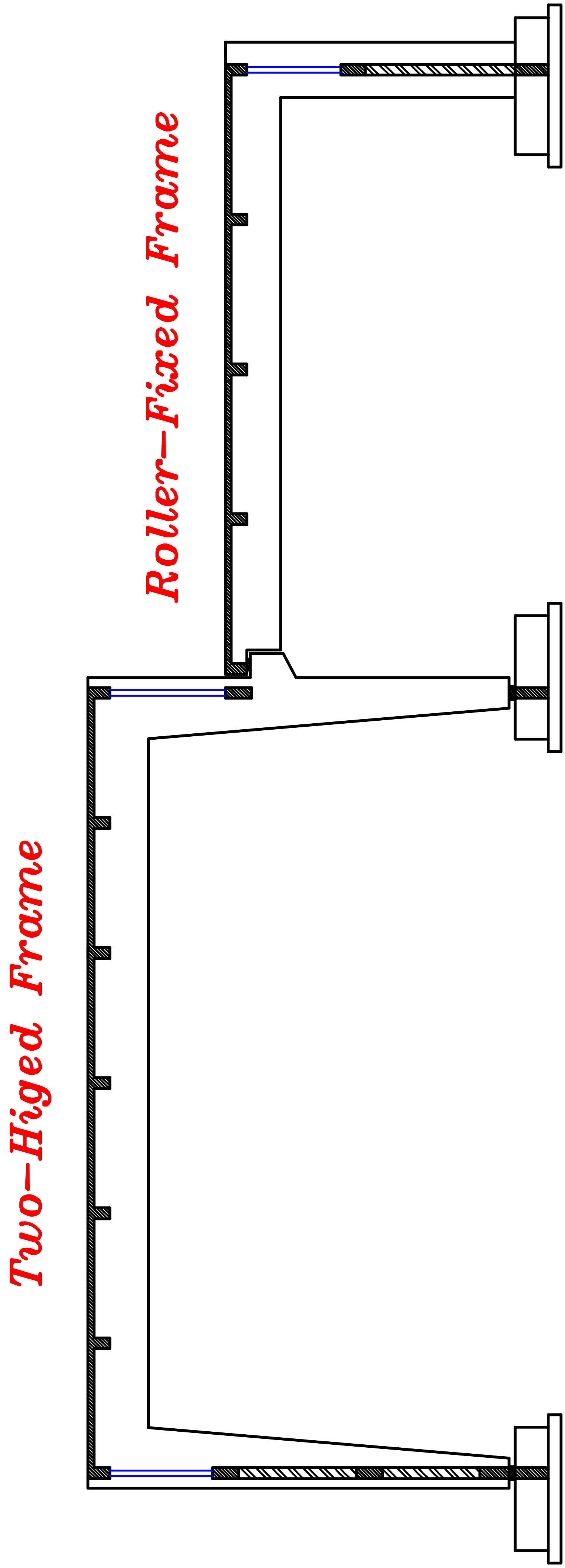
Roller Fixed Frame

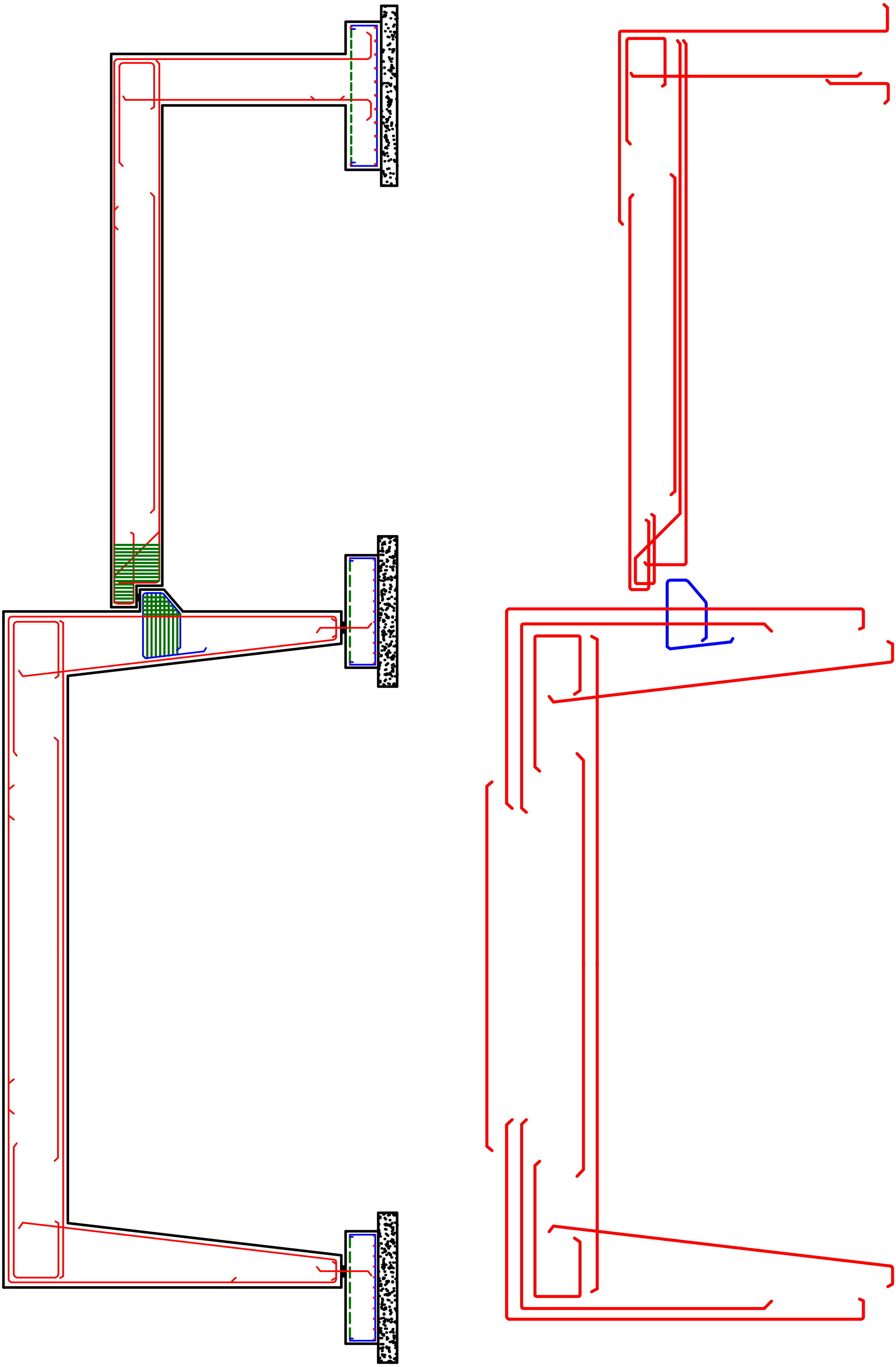
Solve using
Moment Distribution Method

Solve using
Virtual Work Method

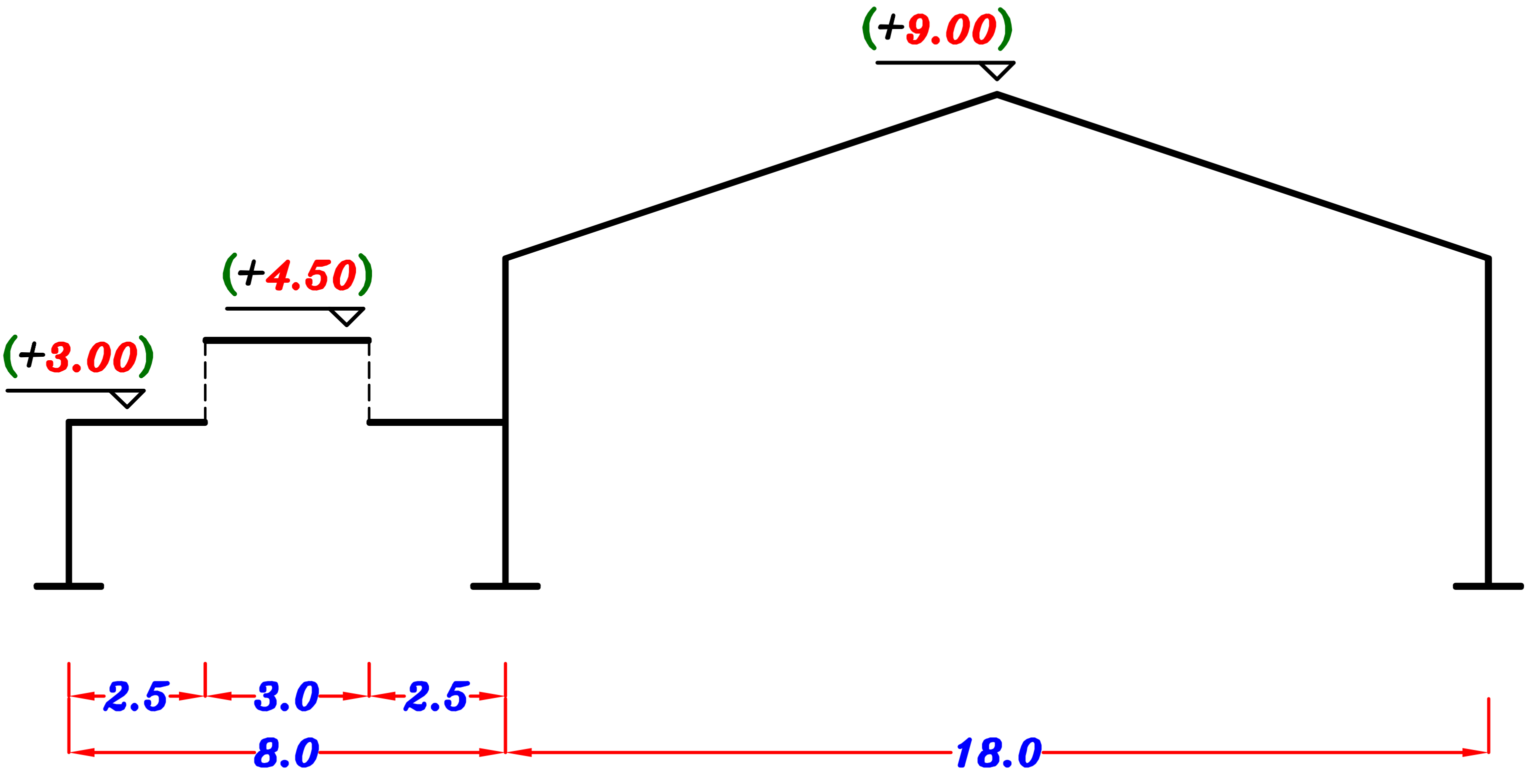




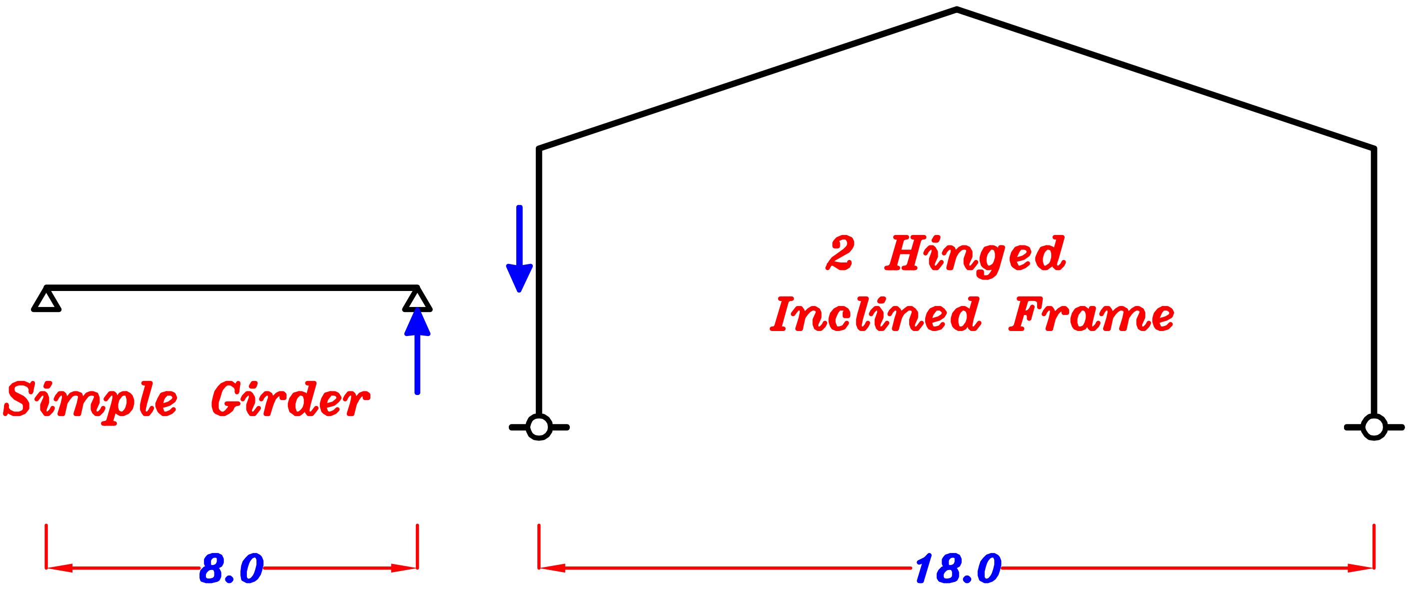

Roller–Fixed Frame
Two–Higed Frame



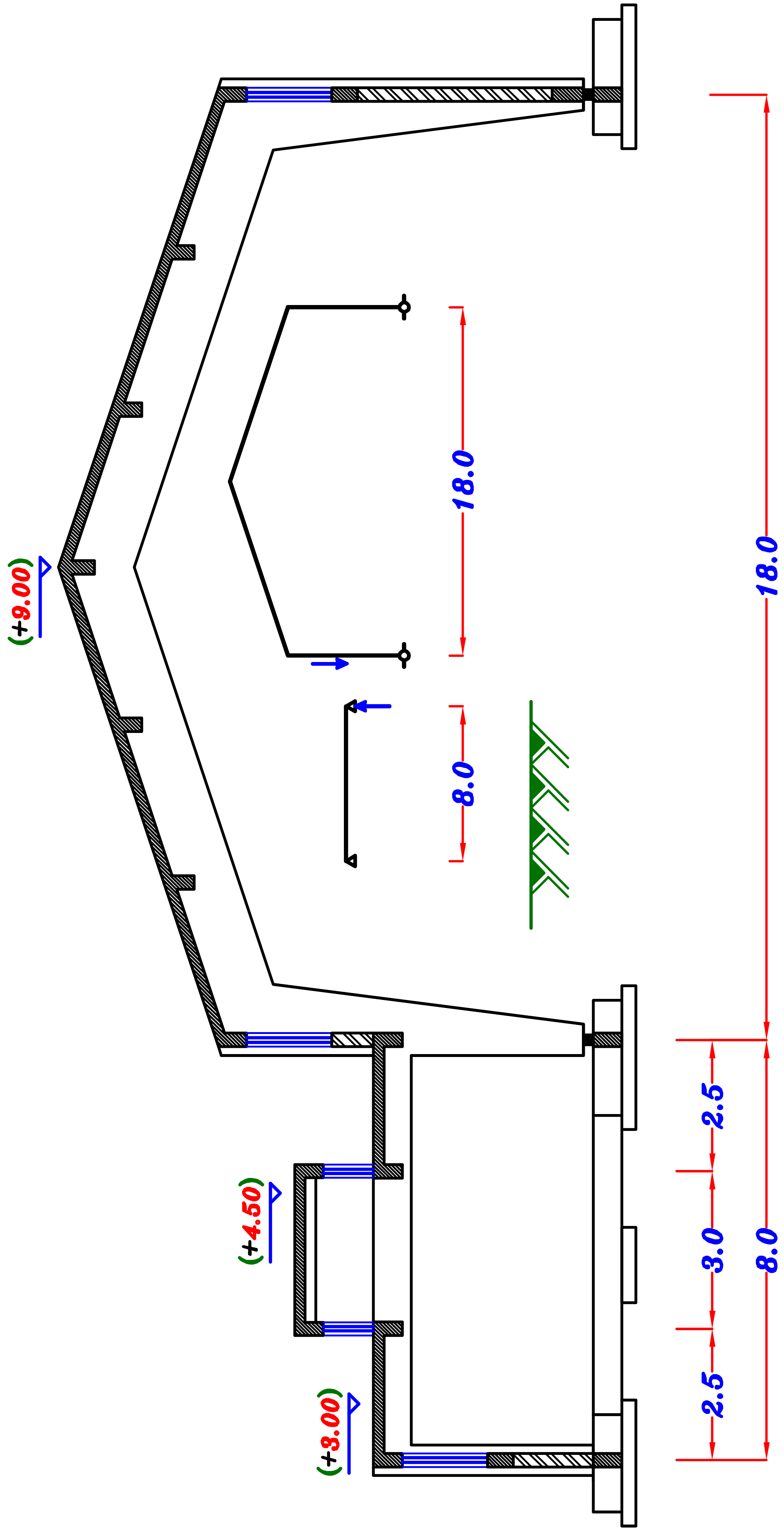
Example.



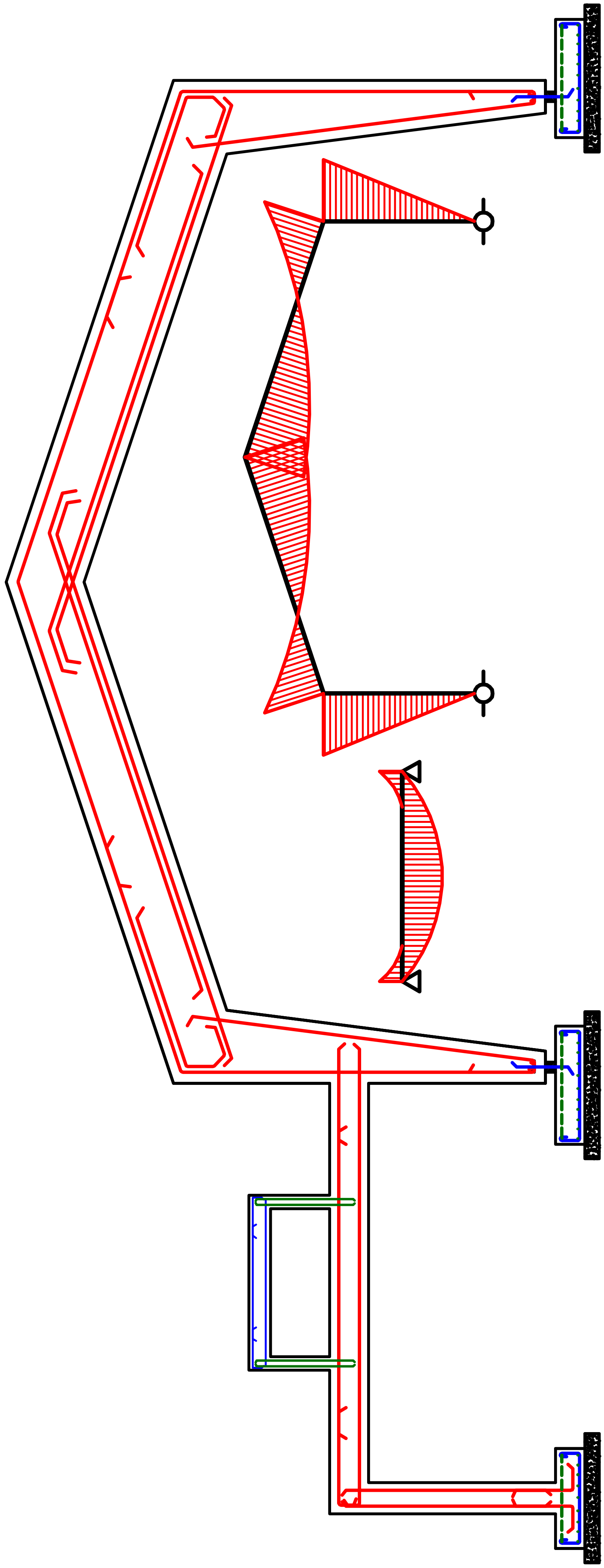
(+9.00)
(+4.50)
(+3.00)
2.5
3.0
2.5
8.0
18.0



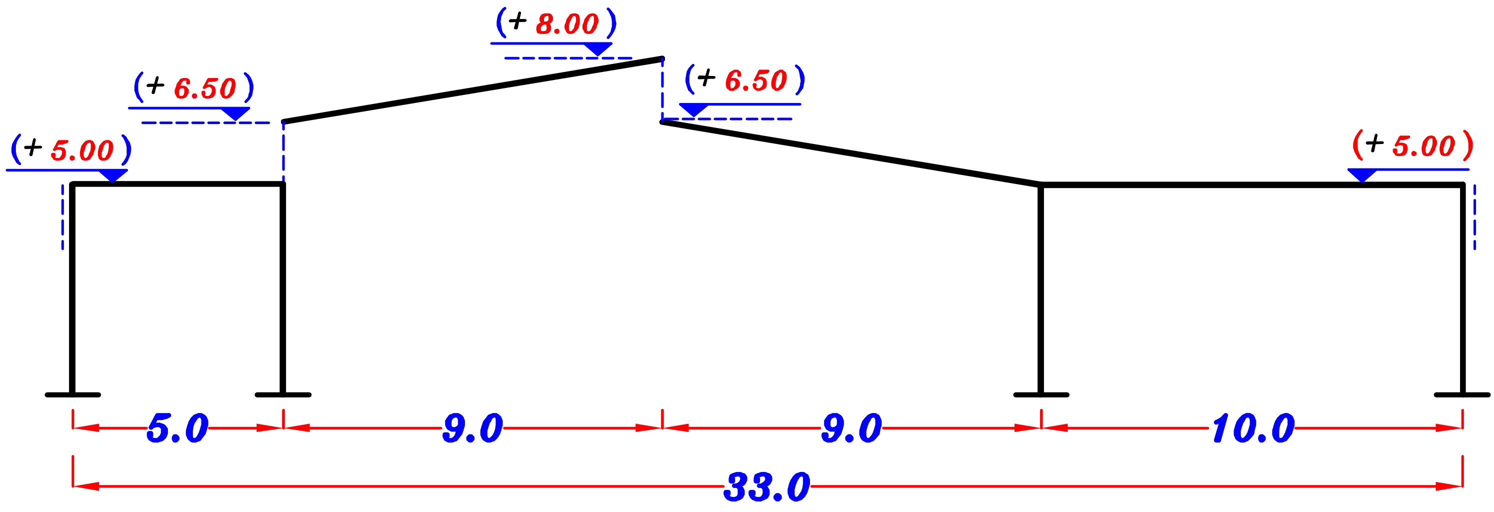
2 Hinged
Inclined Frame
Simple Girder
8.0
18.0



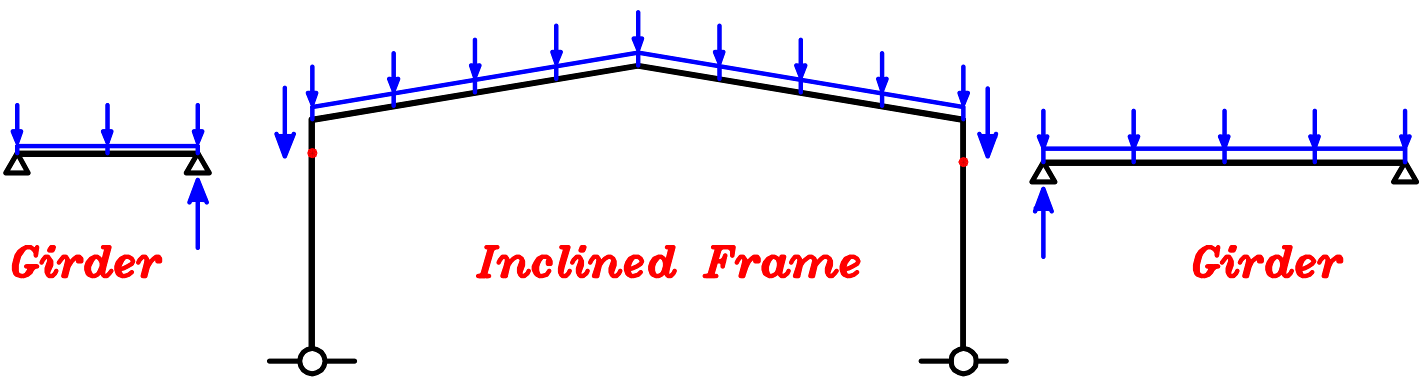
(+9.00)
18.0
8.0
(+4.50)
(+3.00)
18.0
2.5
3.0
2.5
8.0



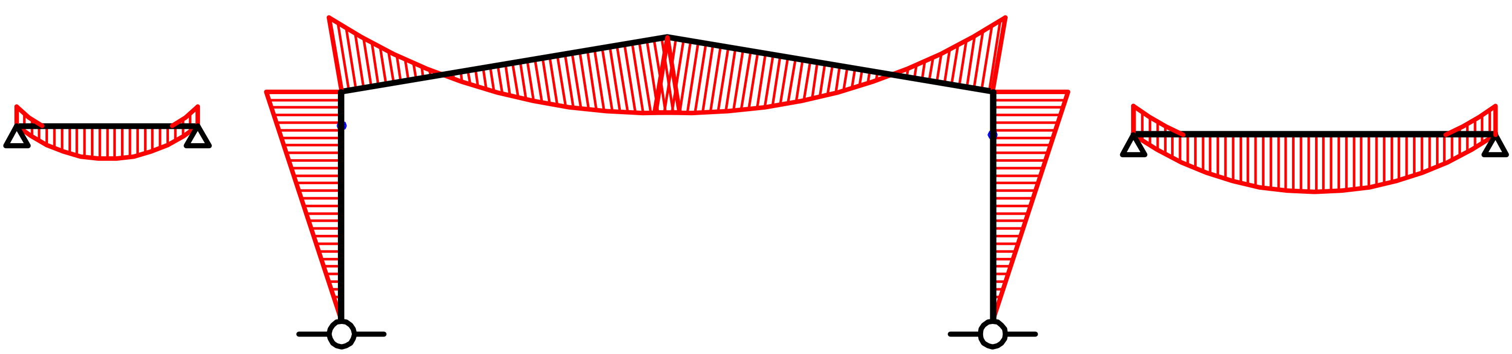
Example.

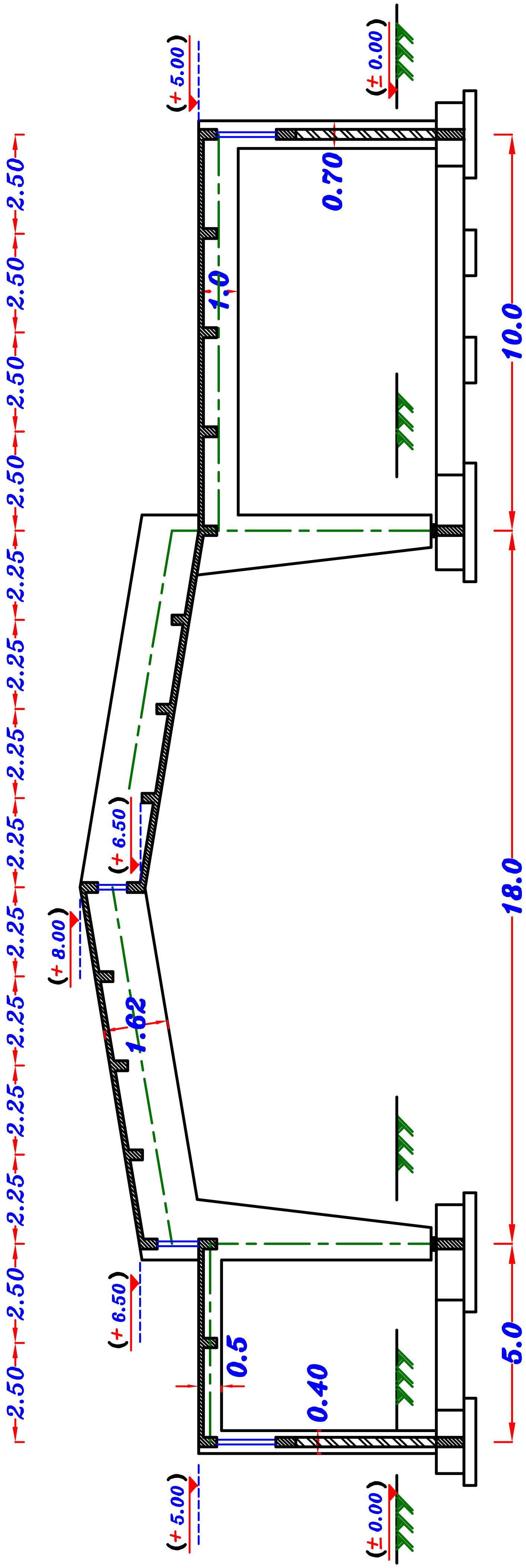


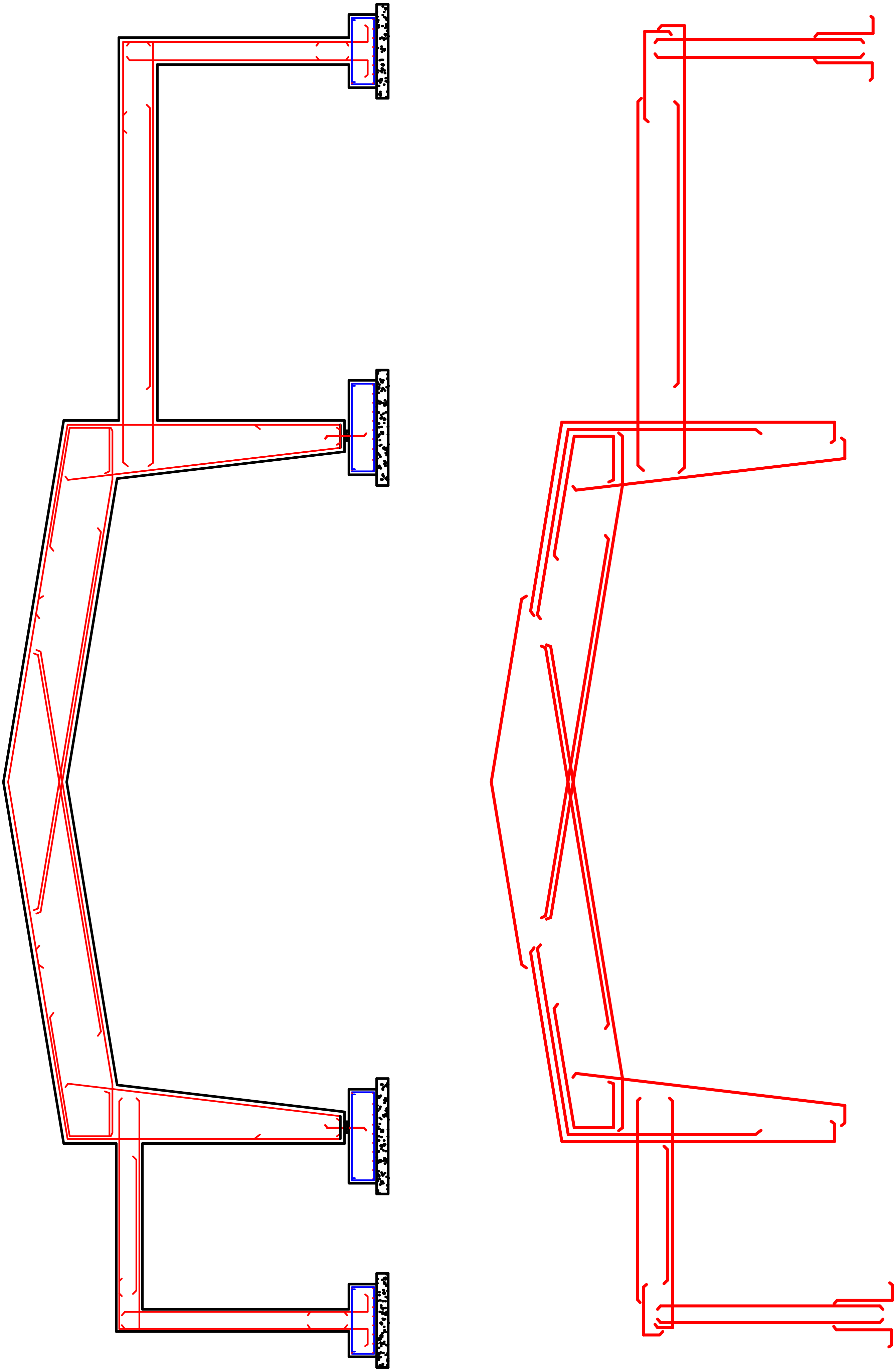
(+ 8.00)
(+ 6.50)
(+ 6.50)
(+ 5.00)
(+ 5.00)
5.0
9.0
9.0
10.0
33.0



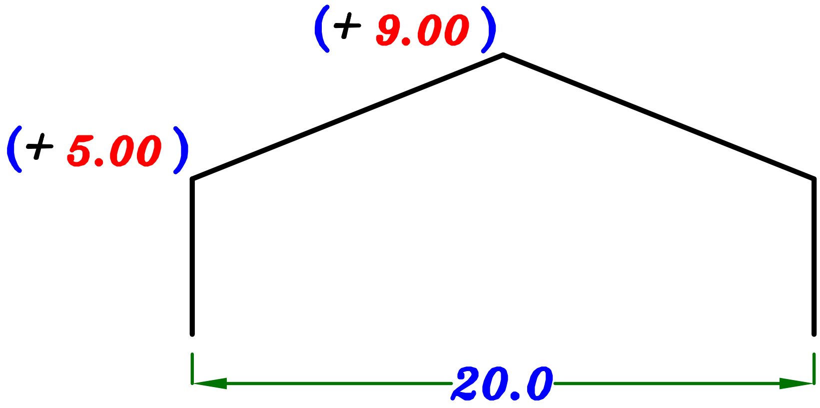
Girder
Inclined Frame
Girder

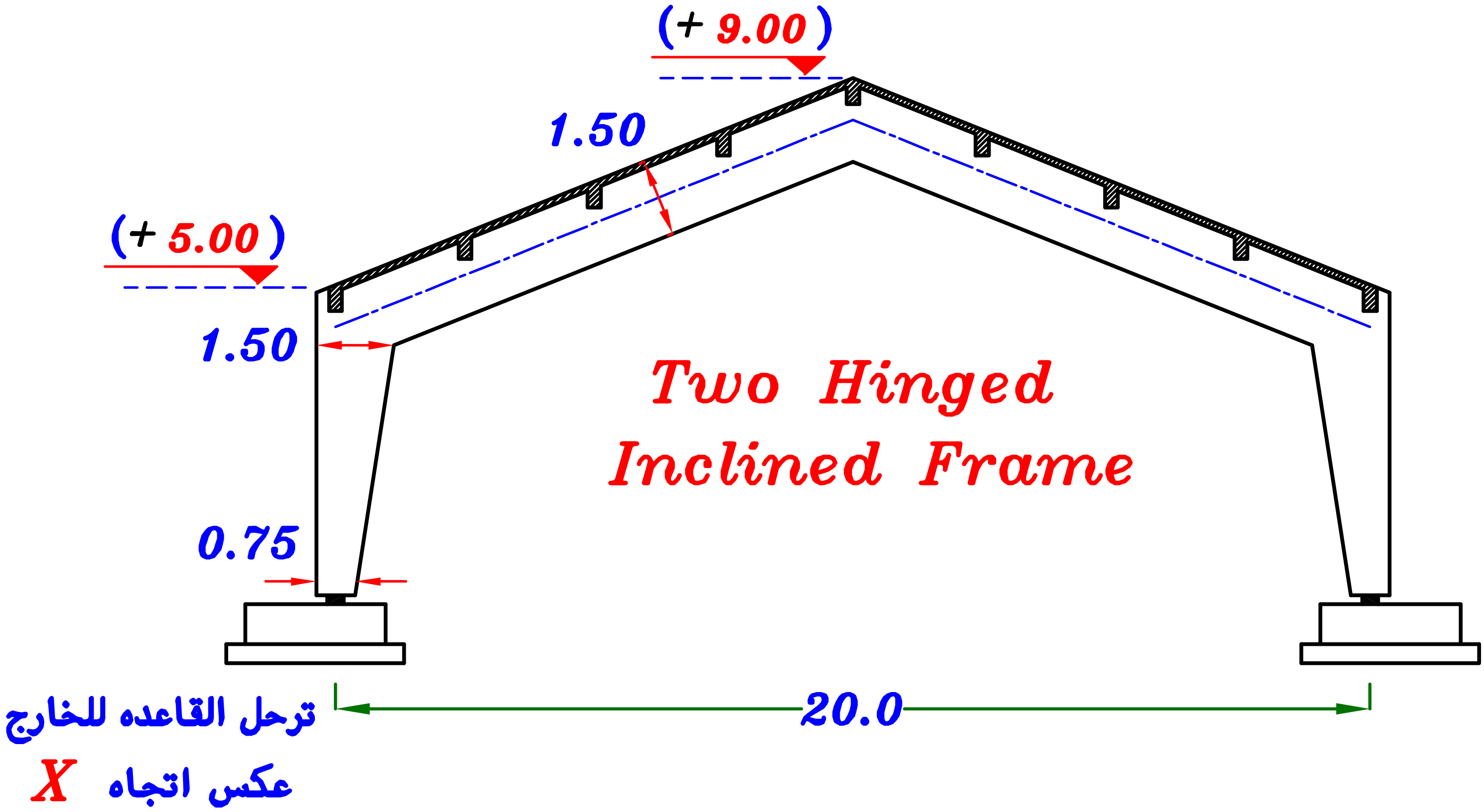


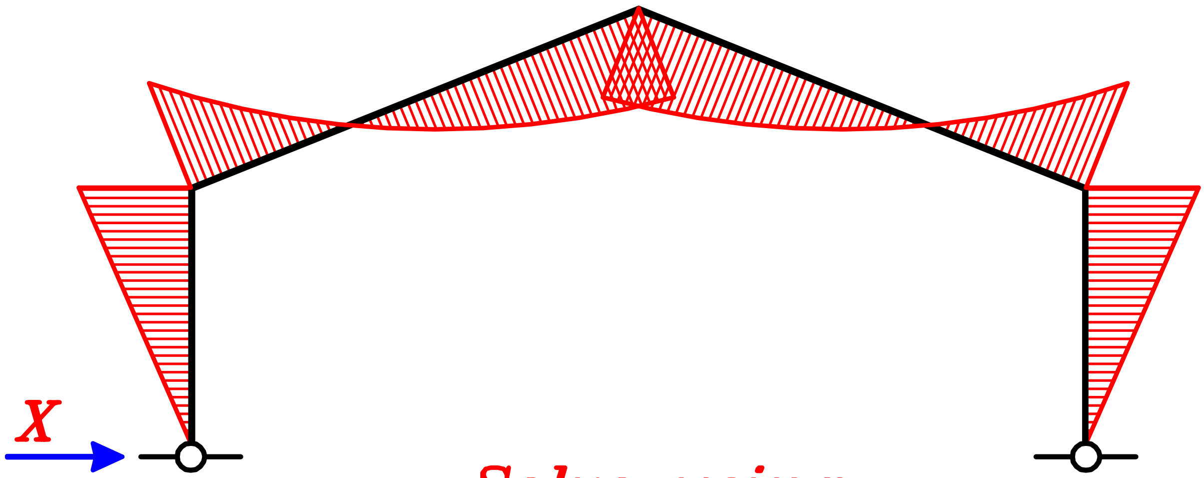

2.50
2.50
2.50
2.50
2.25
2.25
2.25
2.25
2.25
2.25
2.25
2.25
2.50
2.50
10.0
18.0
5.0
0.70
1.0
1.62
0.5
0.40
(+5.00)
(±0.00)
(+6.50)
(+8.00)
(+6.50)
(+5.00)
(±0.00)



Example.

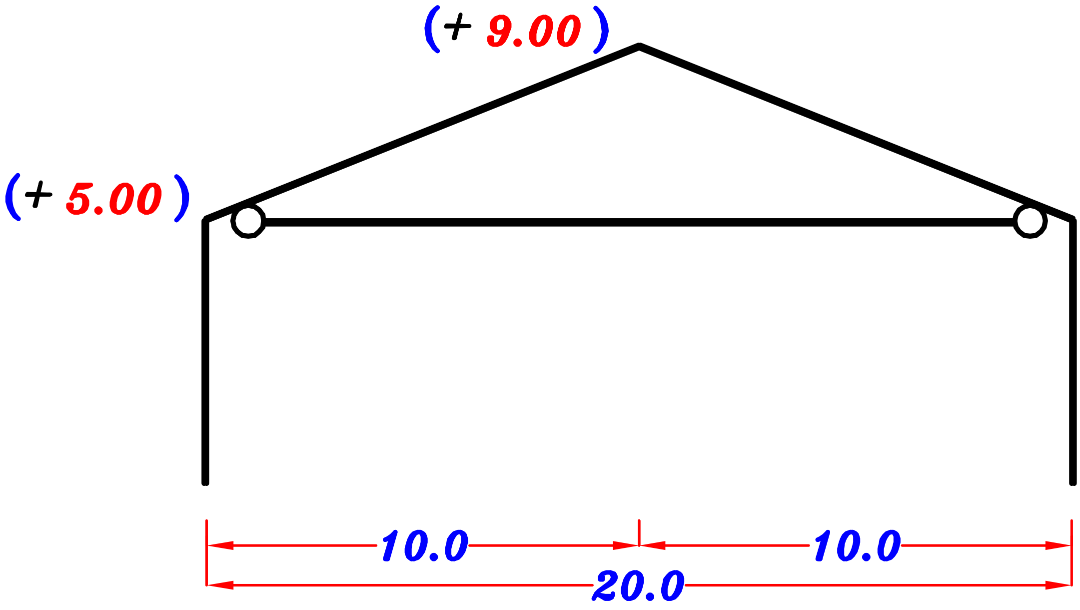






Solve using
Virtual Work Method

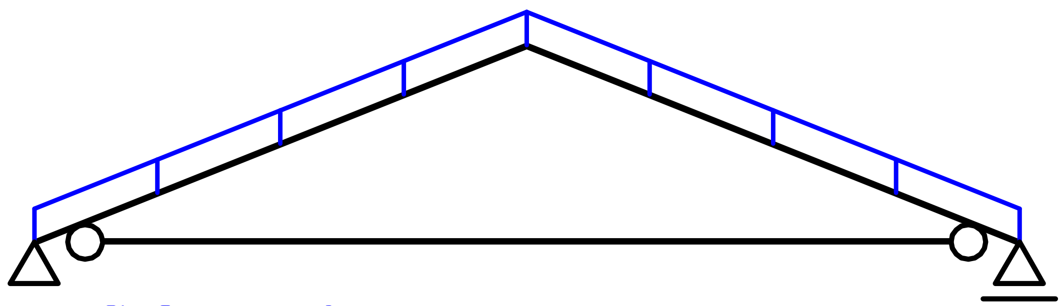
Note.



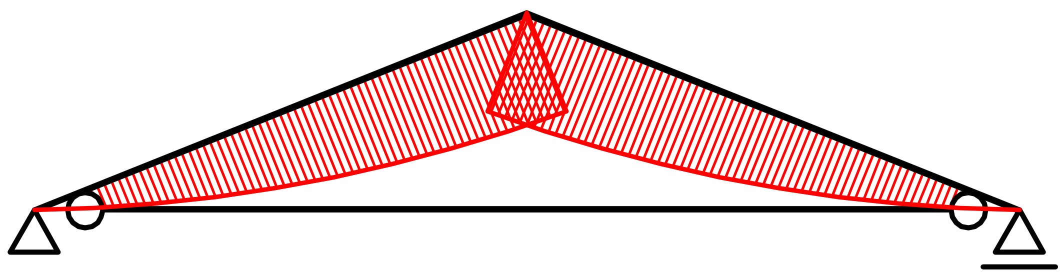
Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

نظرا لوجود tie فان ال tie تعمل على سحب القوى الافقيه من على الاعمده

و بالتالى لا يوجد عزوم على الاعمده فيكون ال system عباره عن Girder



Solve using Virtual Work Method

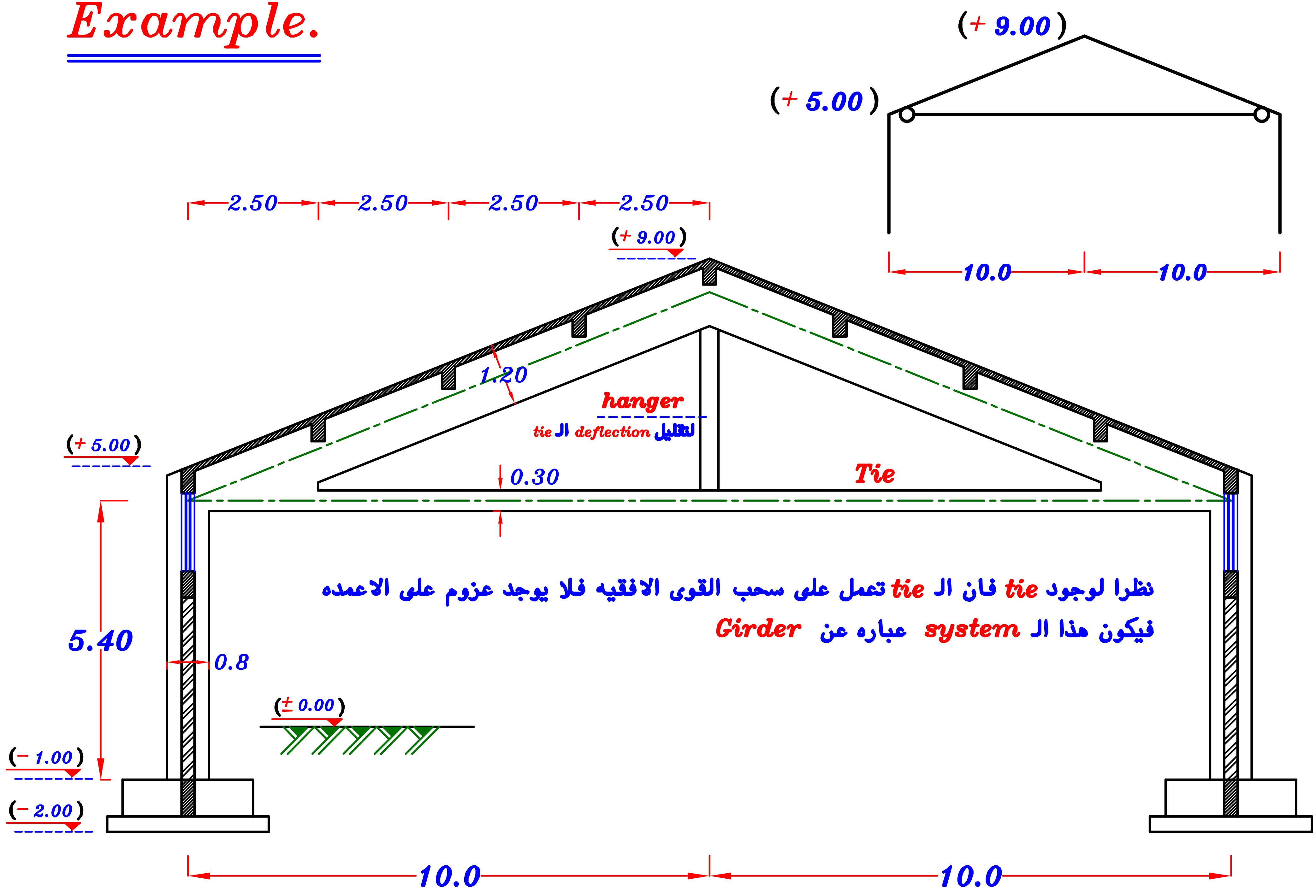


لكن نظرا لوجود Extension لل Tie فيتكون عزم صغير على الاعمده

لن يستدعى أن نرحل القواعد لكن سنكمل تسليح الكمره داخل العمود حتى لا تحدث

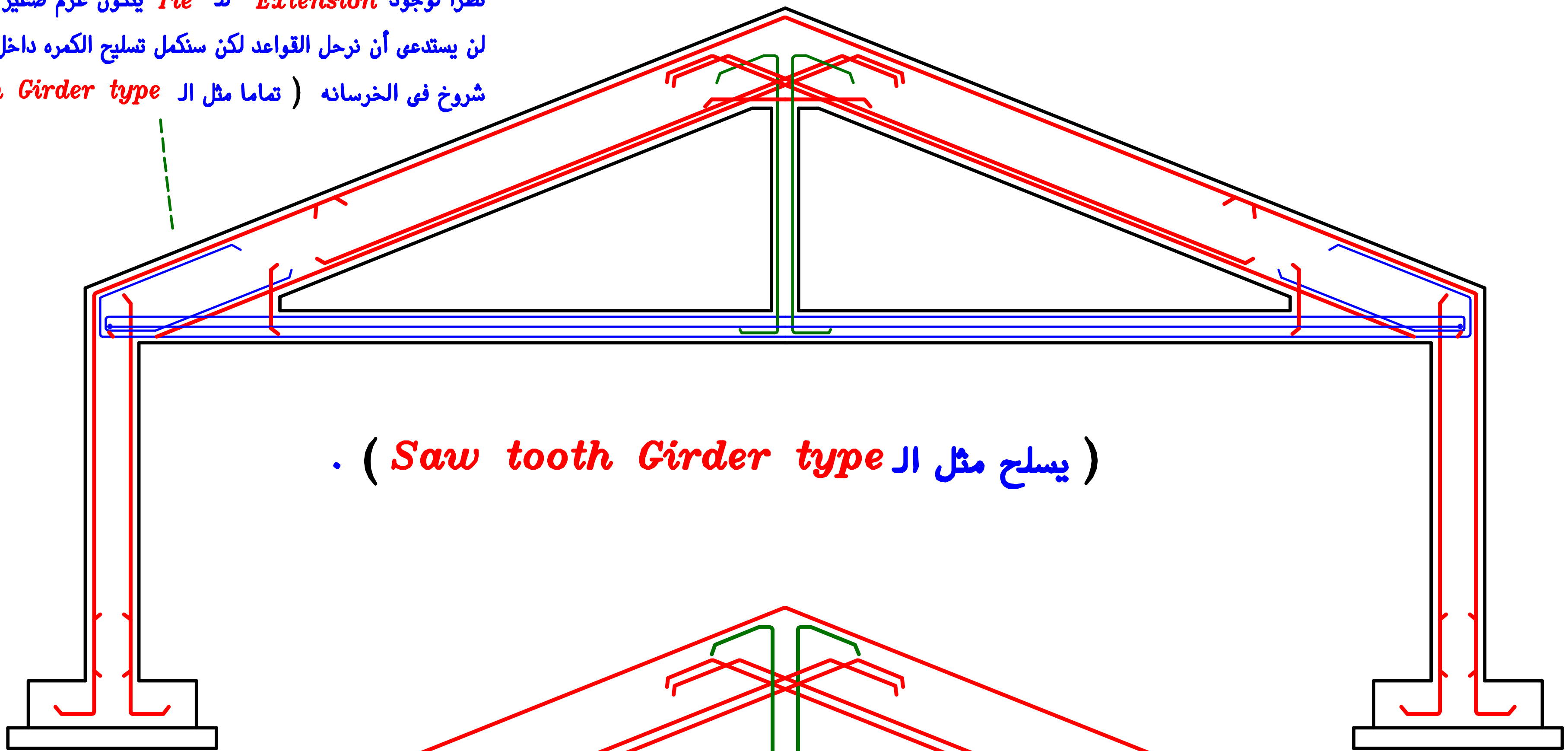
شروخ فى الخرسانه (تماما مثل ال Saw tooth Girder type) .

Example.

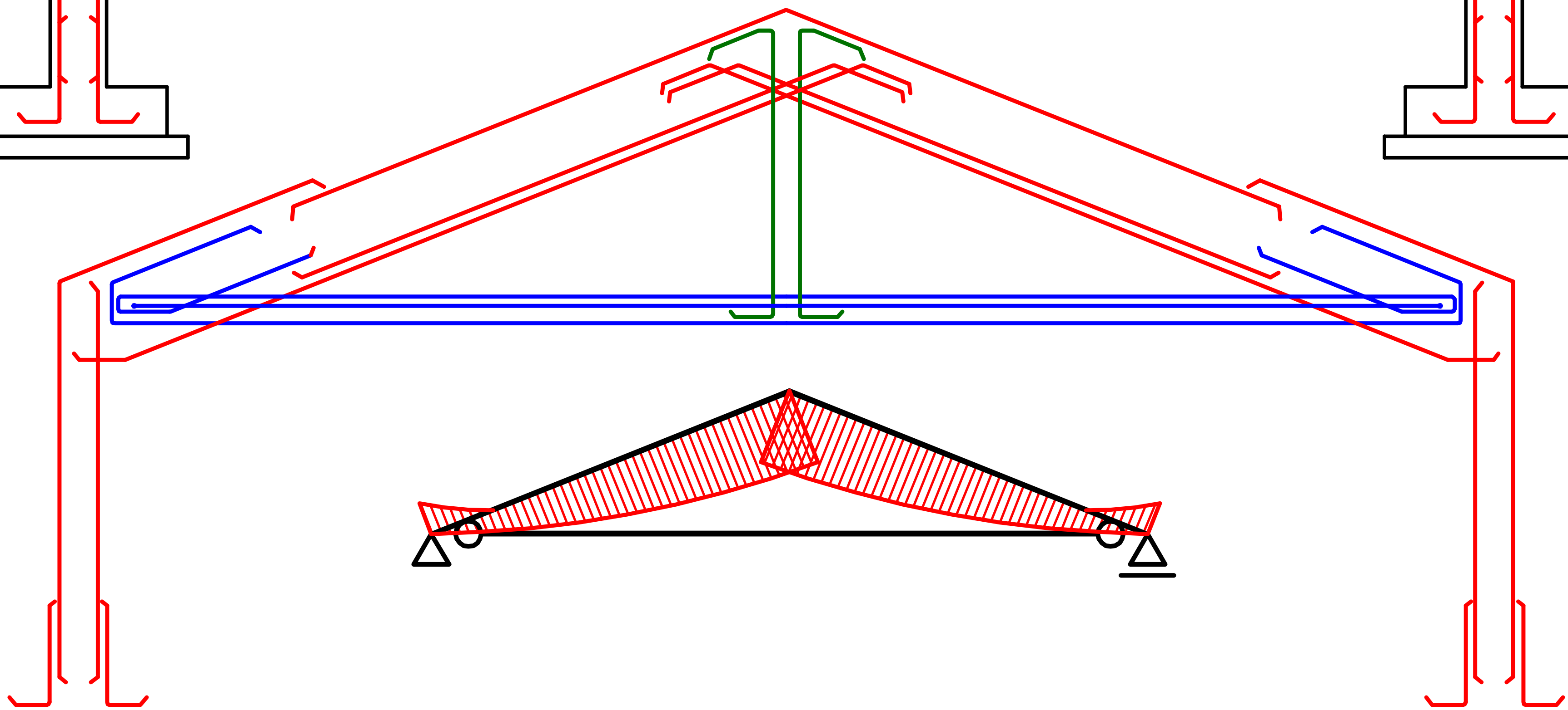


(+ 9.00)
(+ 5.00)
10.0
10.0
2.50
2.50
2.50
2.50
(+ 9.00)
1.20
hanger
tie ال deflection لتقليل
(+ 5.00)
0.30
Tie
نظرا لوجود tie فان ال tie تعمل على سحب القوى الافقيه فلا يوجد عزوم على الاعمده
فيكون هذا ال system عباره عن Girder
5.40
0.8
(± 0.00)
(− 1.00)
(− 2.00)
10.0
10.0

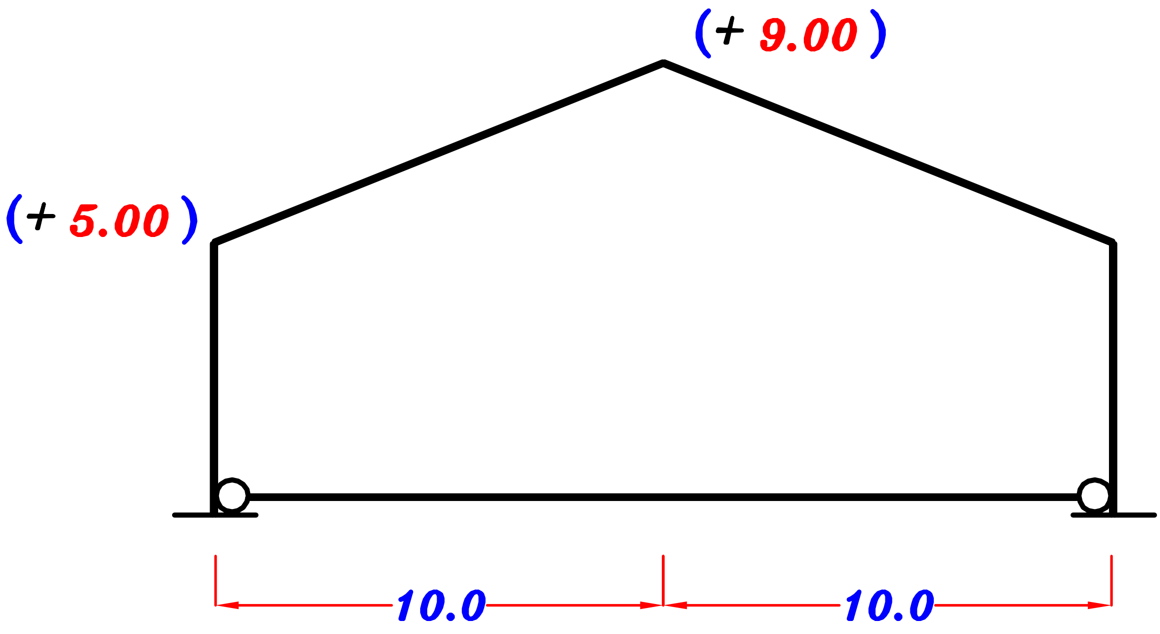
نظرا لوجود *Extension* لل *Tie* يتكون عزم صغير على الاعمده
لن يستدعى أن نرحل القواعد لكن سنكمل تسليح الكمره داخل العمود حتى لا تحدث
شروخ فى الخرسانه (تماما مثل ال *Saw tooth Girder type*) .



(يسلح مثل ال **Saw tooth Girder type**) .

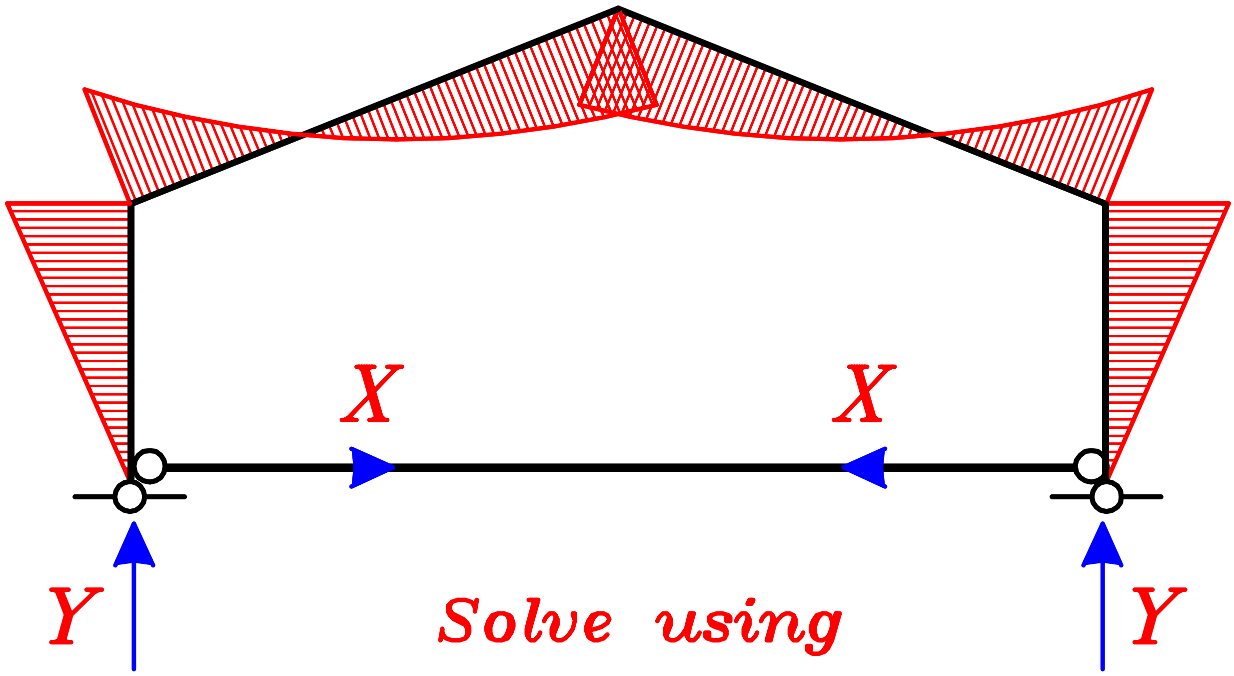


Note.

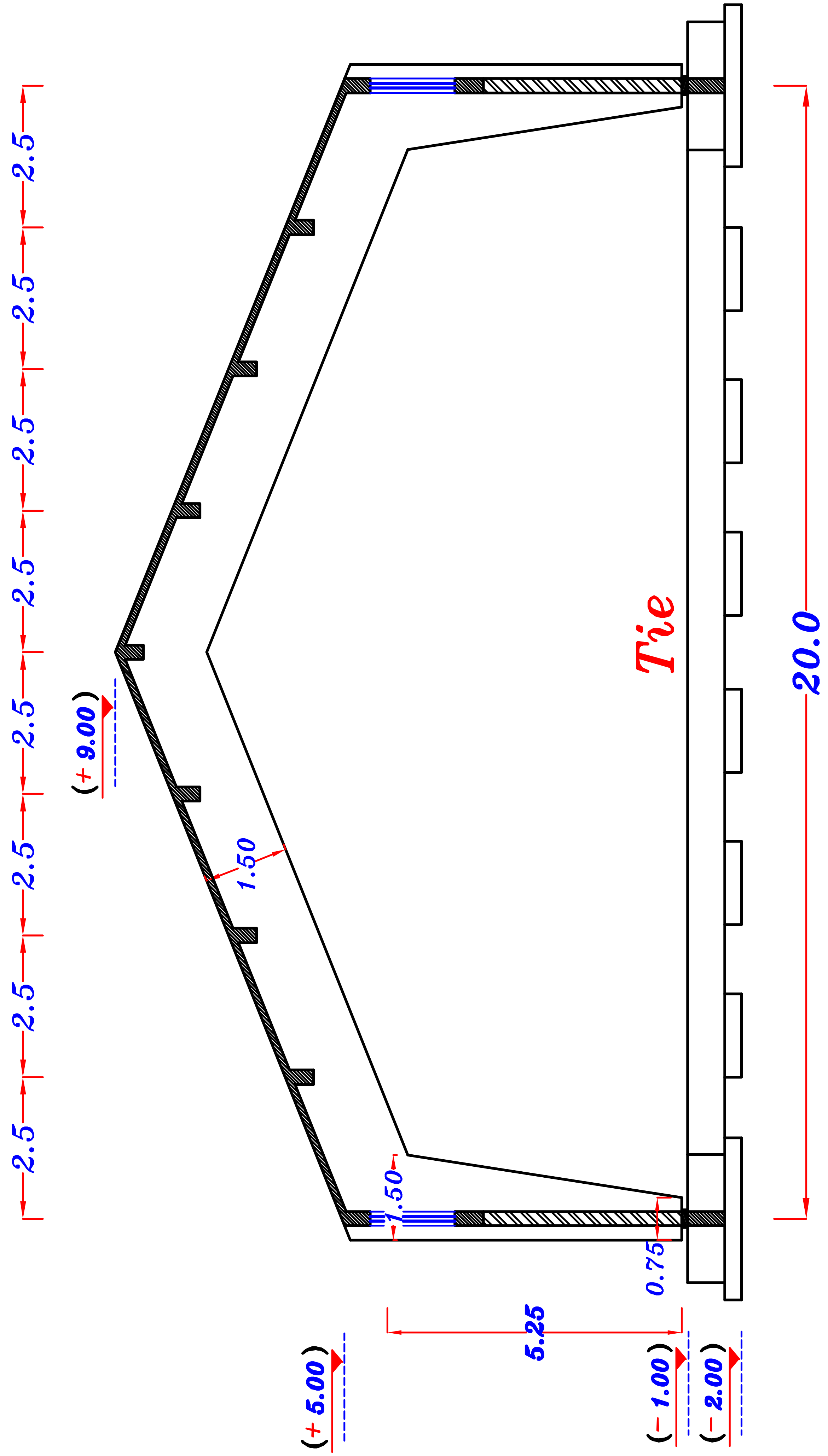


Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

نظرا لوجود *tie* فان ال *tie* تعمل على سحب القوى الافقيه من على القواعد
و بالتالى لا يوجد ترحيل للقواعد



Solve using Virtual Work Method or Approximate


2.5
2.5
2.5
2.5
2.5
2.5
2.5
2.5
(+ 9.00)
1.50
1.50
0.75
Tie
20.0
5.25
(+ 5.00)
(− 1.00)
(− 2.00)